ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLIV. No. 4. NEW YORK, SATURDAY, JANUARY 23, 1904. ISSUED WEEKLY

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PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: 40 Dearborn Street, Chicago, Ill. . . CHARLES FFRENCH, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

SUBSCRIPTIONS

One Year, United States and Canada $3.00
One Year, Foreign Countries 5.00
Single Copies, each 10
Copies supplied for only one year back, each 25

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CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

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CARE AND MANAGEMENT OF STORAGE BATTERIES.

The value of our old friend, the storage battery, for so many years derided and disparaged is at last receiving recognition. It used to be said not long ago that a battery was unreliable, was apt to break down just when most needed, and that in general the space it occupied was more to be desired than the battery itself. Now we are learning that the faults we attributed to the battery were really faults of our own; that we were asking more of this quiet auxiliary than we expected of any of the noisier devices which were supposed to be more reliable. The very fact that a battery did not cry out when misused led to its neglect and misuse. If a battery only had some part that revolved which would stop, or if it would only spark when things were going wrong, the attendants might give it a moment's consideration and an occasional examination. But a quiet motionless device that makes no noise is apt to get little or no attention until matters have gone beyond repair. Now many of us are learning better, but there is still much room for improvement, and we believe the series of articles on the care and management of storage batteries begun in this issue will be read with interest and benefit. The author, Mr. Edward Lyndon, speaks with knowledge born of experience as for some years past his work has lain in this field and his remarks are the result of actual work and therefore of particular value in practice.

GOOD ROADS.

During the latter part of this month there will probably come up for action a bill which is now pending in Congress, concerning deeply the question of good roads throughout the United States. The Brownlow bill, introduced by the Hon. Walter P. Brownlow, of Tennessee, and the Hon. Jacob H. Gallinger, senator from New Hampshire, has for its essential object the appropriation of $24,000,000 as national aid for the building of wagon roads. This sum is to be distributed to each state according to its population, except that no state is to receive less than $250,000. This is not the extent of the bill, however, for each state or county receiving a certain sum of money must contribute a like amount, so that in all there will be available, if this bill should pass, $48,000,000 for good roads.

Good Roads a Part of the General Improvement.

Good roads will mean increased comfort to every one who has occasion to make use of them, whether he be a farmer, a sportsman or merely a pedestrian. They should be placed in the same category as improved railway service or improved canals. The economical transportation of product in any form whatsoever is one of the essentials of modern progress and prosperity. The fact that the farmer has not been able to build good roads unaided should not place him in discredit. The very fact that he has been under a heavy burden in transporting his product over bad roads is an assurance that he wants good roads if it is at all possible to get them.

Would Be an Incentive to Adoption of Motor-Driven Vehicles.

In several states in the Union state aid has been given to the building of good roads, and where this has been the case, every one concerned has been benefited materially. Aside from the direct influence that good roads would have upon horse-drawn traffic, they would prove a decided incentive to even better conditions than this; and with a national system of good roads, it would not be long before the horse would be entirely withdrawn and his place taken by motor-driven vehicles, leaving out of the question at this moment the type of motor to be employed.

THE AUTOMOBILE SHOW IN NEW YORK.

The fourth annual automobile show opened at Madison Square Garden, New York city, on Saturday, January 16, to continue until Saturday, January 23. The show this year was held under the auspices of the Automobile Club of America, the National Association of Automobile Manufacturers, and the Madison Square Garden Company. The number of exhibitors was very large, and, in some instances, original space had to be cut down in order to accommodate all of those wishing room. Electric vehicles were more in evidence than ever before. While there was not much radical change in the matter of design, the motor parts and accessories show considerable change. This is particularly true along those lines which make for substantial construction, and also in the equipment of battery outfits. The combination of internal combustion engine and electric dynamo and motor is a popular form of apparatus, and, particularly for heavy trucking work, seems to have a field of its own. In the way of accessories, ignition dynamos, spark coils, vibrators, primary batteries, etc., were exhibited in great numbers.

THE INSTITUTE DINNER.

The annual dinner of the American Institute of Electrical Engineers will be of particular interest this year as it will be commemorative of the birthday of Thomas Alva Edison, February 11, being held on that day at the Waldorf-Astoria Hotel, New York. Mr. Edison will be the guest of honor. It is eminently proper to honor, in this way, one who, although distinguished in many fields of invention and application, is particularly associated with the development of electrical engineering. Beginning his labors when there was but one branch of the art, the telegraph, he has worked in and left his mark on practically every one of the many branches which have spread out in all directions during the past quarter of a century.

The Edison Medal.

On the occasion of the Institute dinner, another event will be recalled with a fitting ceremony. To commemorate the twenty-fifth anniversary of the successful introduction of the incandescent lamp, a medal, to be known as the Edison Medal, is to be endowed. This medal is to be awarded, every year, to some young man in recognition of a brilliant piece of research work. Thus the name of Edison, already associated with so many inventions and discoveries and which has been an inspiration to many an ambitious young man, will now take on a new significance. It will also stand for a reward of merit.

THE NATIONAL BUREAU OF STANDARDS.

On another page of this issue we publish a letter from Mr. Edwin F. Northrup, which calls attention to the excellent work now being done by the National Bureau of Standards, at Washington. We have repeatedly commented upon the value of this bureau, as it not only promotes scientific research, but its work is equally important to the manufacturers, as by making it easy to obtain correct standards, it enables them to adjust and rate accurately their apparatus. We take pleasure in presenting this letter from one who is familiar with and appreciates the work of the National Bureau of Standards.

CENTRAL STATION BREAKDOWNS.

Several unfortunate breakdowns of central light and power stations have occurred within a short time in England, which emphasize the great risk of concentrating all the generating equipment in one room. As electric lighting and power distribution grow, generating stations become larger, and the interference to business from the stoppage of supply becomes more serious, as to keep pace with the demand for electric power, not only have the stations increased, but improvements in apparatus have made large units more desirable than smaller ones. The control of these machines and of the output of the station has made necessary the construction of expensive and complicated switching gear. To protect, as far as possible, all machinery against accidents, devices automatic in their action have been developed, the whole tendency seeming to be toward greater complexity and an increased number of auxiliary devices, each one of which must be kept in perfect order. Thus, while the generators themselves are less liable to breakdowns due to imperfections than formerly, there are now more points where accidents may occur to a system than was formerly the case.

Effect of a Breakdown.

When an accident occurs at any point, unless there has been ample provision for confining the arc which may be formed, the trouble is apt quickly to spread, due to the enormous power poured into the defective apparatus; and what started as a breakdown of a minor piece of apparatus may spread rapidly and soon involve the entire switchboard, and possibly destroy the building and its equipment. The power involved in such a disaster is so enormous, and the heat produced is so intense, that there is little that can stand against them. Marble and slate melt away; brass and iron are burned and volatilized; melted stone and metals flow down over the floor, and insulating materials, such as rubber, take fire and burn fiercely. The very ability of the generators to stand excessive overloads enables them to pour into the fire an increasing amount of energy, and thus to work their destruction.

Isolation of Machinery.

These dangers are well recognized by engineers, and the development now taking place is toward greater safety, to be secured by isolation. The first steps in this direction were to separate the switches and other devices by marble panels. They were then enclosed in brick chambers, each pole of a switch being separated from the others. The switches are, in many cases, located at a distance, or entirely separated, from the generating room; but even with all these precautions, the breakdown of a single switch may be followed by that of a generator, and thus spread to the others. To avoid this two plans are suggested. In one, several smaller power stations are constructed, instead of one large one. These are located as may seem best, and operate together. In the other plan it is proposed to divide the generating room into sections, each shut off from the others, and each constituting a smaller, but complete, power station. In this case a fire due to the failure of any one unit could be confined to that one room. Development in this

direction is assisted by the introduction of the steam turbine. The floor space required for such generating units may be so small, compared with that required by the boilers, that a new arrangement of boiler and engine room seems desirable. Thus, the new power station of the Boston Edison Company will consist of a long generating room equipped with steam turbines, each of which will have its own boiler equipment, the boiler rooms running at right angles to the generating room. The whole station will then practically consist of a number of independent stations, all identical, and placed side by side for convenience.

Expense of Protection Justified.

Thus, while a breakdown at the station is more serious to each user of electric power because we are more dependent upon it than ever before, the enormous plants are far less liable to trouble than the old and simple stations. The importance of maintaining an uninterrupted supply justifies the expense and makes the cost a minor consideration.

CARE AND MANAGEMENT OF STORAGE BATTERIES—I.

BY EDWARD LYNDON.

If the battery equipment of a station be given the same care and attendance as the generating machinery and the same regard be paid to the battery, with respect to the service performed in relation to its capacity, no more trouble should be experienced with one than the other.

There is, however, a tendency on the part of some of the operators of battery equipments to let the part of the apparatus run itself until some condition arises which indicates that the battery is in trouble, and then attempts are made to rectify this trouble.

One characteristic of the storage battery, and perhaps an unfortunate one, is that it does not spark, run hot or loosen up joints when service other than the normal is called for. This is unfortunate in that it invites inattention and generally gets it.

Many of the alleged storage battery troubles would disappear if a regular and thorough system of records and inspection be adhered to.

The intention of this article is to outline the troubles to which batteries are subject and the methods of treating same, also to indicate the more important records which should be taken.

SULPHATATION.

The normal action of a storage battery on discharge is the formation of lead sulphate on both the positive and negative electrodes, and that of charge, the converting of this sulphate back to sponge lead on the negative and peroxide of lead on the positive electrodes.

The active masses of both plates are continually changing in volume with every charge and discharge, expanding on discharge and contracting on charge. This change in volume is more marked in the case of the negative material than with the positive, the negative active mass, Pb, absorbing twice as much oxygen as the positive, PbO_2, on discharge.

These changes in the sponge lead and lead peroxide to lead sulphate, $PbSO_4$, on discharge and the reduction of this sulphate to the original oxides of lead on charge, are accompanied by corresponding changes in the density of the electrolyte, increasing on charge and decreasing on discharge; this being due to the fact that SO_3 required for the formation of lead sulphate on discharge is taken from the electrolyte, decreasing its density, and on charge the SO_3 in this lead sulphate is given up to the electrolyte, increasing its density.

This formation of lead sulphate on discharge is perfectly normal and is not harmful unless an excessive amount is formed, and to so limit the amount formed on each discharge it is usual for the manufacturers to specify that discharge should be discontinued when the terminal electromotive force per cell has dropped to 1.8 volts, with normal rate of discharge flowing.

The ending of discharge at this point is not to be taken as an indication that all the active agents on both positive and negative plates have been converted into lead sulphate, but that the maximum amount has been formed that can easily and efficiently be converted back to the original substances on the passage of current in the opposite direction, that is by charging.

If discharges be persisted in, in which greater amounts of sulphate have to be formed for the production of the current, the resulting excess sulphate will in time become harmful to a greater or less degree, as this sulphate will penetrate deeper and deeper into the body of the plate until it becomes practically impossible for the charging current to reduce this product of discharge.

When sulphatation has reached a certain degree it can not be reduced by the passage of current, and if certain portions of a plate become sulphated to this extent then these portions are simply inactive and perform no useful work, with the result that the capacity of such a plate is correspondingly reduced.

Lead sulphate in itself possesses no electrical conductivity and the production of this sulphate is accompanied by an increased internal resistance of the cell. Higher charging voltages are therefore required to force current through a sulphated battery than are necessary for cells in normal condition.

In fact, one good indication of sulphatation is the high-potential difference across cell terminals at the beginning of a charge. This high-potential difference being due to the drop caused by passage of current.

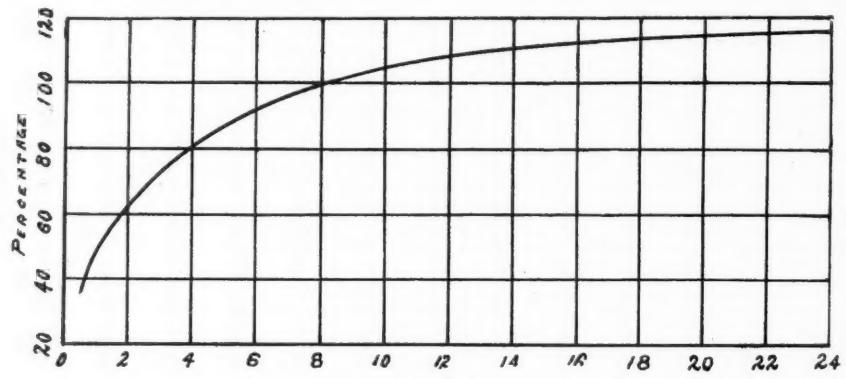
The effects of excessive sulphatation, then, are to increase the internal resistance and to cause the active agents to expand to a harmful degree, and this expansion on discharge with contraction on charge tends to separate the active agents from the supporting grid or frame, thus giving an additional increased resistance along the line of contact of the supporting element and its active mass, with a further tendency to decrease the capacity of the plate by isolating some of the active material to the extent that it becomes inactive.

The question of sulphatation and resulting changes in volume of the active materials is one of degree, and the design of storage battery plates is such as to allow for the limited expansion and contraction between normal discharge and charge with no resulting harmful effects, and the discharge should never be protracted to the point where the interior portions of the active masses are converted to sulphate.

The 1.8-volt point at which discharge is cut off holds only when this voltage per cell is in connection with some fixed rate of discharge, as the mere voltage taken without due consideration to the rate of discharge has absolutely no meaning, and when batteries are subject to rates greater or less than the normal eight-hour rate of discharge the cutoff point, as determined by voltage, should be less or greater than the 1.8-volt point, and the proper point of cutoff may be determined by capacity and voltage curves for the

particular type of cell used in the battery. Fig. 1 shows such a set of curves for a certain cell, the voltage curve shows directly the point of cutoff per cell for different rates of discharge, and from the capacity curve the ampere-hour output at any rate may be calculated.

In the curve shown the ordinates represent percentages in ampere-hours, the capacity at the eight-hour rate being taken as 100 per cent, and the different ratios of discharge are shown on the horizontal scale, or if the cells corresponding to this curve be rated at 100 amperes for eight hours and the regular rate of discharge be for one hour, then, as shown by the curve, at this rate the ampere-hour output is fifty per cent of the capacity at the eight-hour rate, or 400 ampere-hours at the one-hour rate, giving 400 amperes



COMPARATIVE CAPACITIES AT DIFFERENT RATES OF THE STATIONARY TYPES.

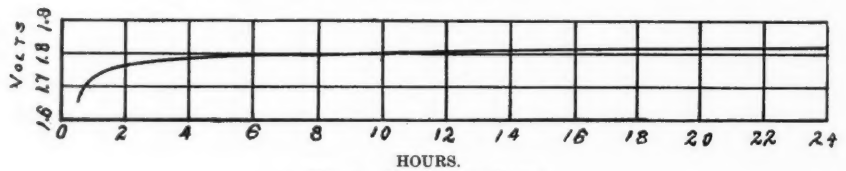


FIG. 1.—DISCHARGE RATES.

for one hour and the cutoff point being 1.74 volts, given by the voltage curve.

When batteries are to be worked at rates other than the normal the manufacturer should be consulted as to the proper point of cutoff.

Unless the proper point of cutoff be adhered to the continual formation of excess sulphate will finally reduce the capacity of the battery until it can not perform its work. These are conditions of sulphate arising from overdischarge. The natural remedy for sulphatation is charge and plenty of it. The rate at which this charging should be done appears to vary anywhere from one-half the eight-hour rate to the full five-hour rate, varying with different types of plates and in accordance with instructions from the manufacturers; in the former case the rate is increased as the charge continues, and in the latter the rate is reduced with continuation of charge.

In the case of badly sulphated cells, however, the temperature will usually limit the rate at which the charge can be introduced. On account of the increased plate resistance and that of the electrolyte, heat is developed on the passage of current and this current should be so regulated as to keep the temperature of the cell below 105 degrees Fahrenheit at all times.

Sulphatation manifests itself by high potential on the passage of charging current, low voltage on discharge, low density of the electrolyte and when it has proceeded very far, by the whitish color of the plates.

When sulphatation to a more or less degree extends over the battery as a whole, the cause for this will be overdischarge or undercharge, it being evident that the same effects may be produced, as far as the formation of sulphate is concerned, if the battery be undercharged.

If, however, this sulphate is confined to one or more cells composing the battery, the remaining cells being in a healthy condition, then some abnormal conditions must exist in the sulphated cells, sulphate being also a product of local action and short-circuits, and these will be taken up under the heading of internal discharge.

Sulphatation of the negative will result if a charged negative be exposed to the air for any length of time and then replaced in the electrolyte, and if for any reason it becomes necessary to remove the plates from a cell while in a charged condition, the negatives should be placed in water or else the rapid oxidization of the sponge lead when exposed to the action of the air will develop considerable heat, and a negative in this condition when replaced in the electrolyte will be subject to local and chemical action with resulting sulphatation.

In the above it is not intended to imply that one or more undercharges or overdischarges will result in the formation of sulphate that will have lasting and harmful effects, for such is not the case. It is the continuation of such methods that will bring about disastrous results. At the same time, however, it is recommended that every charge and discharge be worked within certain limits, dependent upon the cell, unless some abnormal condition arises which calls for excessive discharges from the battery, and under such conditions there should be no hesitancy in calling for the entire battery capacity in the shortest time possible, if required; it is merely the continuous repetition of this excessive work that is to be avoided.

In every case charge should follow discharge in the shortest time possible, as discharged plates in the electrolyte are subject to rapid sulphatation.

If a battery is to be left idle for any length of time some provision should be made for introducing charge as often as once each week. If electrical leakage and local action did not occur, it would of course be possible to let a fully charged battery stand for weeks without any apparent loss, but since these factors are generally present, there must be some provision made for giving the occasional charge; usually an hour's charge at normal rate will suffice.

It might be worth while, if moisture be present in the battery room and where cable connections may easily be removed, to disconnect the separate rows or groups of cells and thus lessen the possibility of leakage.

In case a battery is to be taken out of commission the plates should be fully charged, the acid withdrawn from the cells and replaced by distilled water; the water should be put into the cells as soon as the acid is withdrawn to keep down heating of the charged negatives. The whole battery should then be discharged. In this case, however, the discharge with the plates in water should be continued until the electromotive force of each cell is practically zero, and this requires a very low external resistance; in fact, near the end of discharge the cells must be short-circuited.

After the discharge the water is withdrawn and the plates may be allowed to remain in the tanks until such time as the battery is to be used again, it being only necessary to add the electrolyte and begin charge.

ELECTRIC TRACTION WITH ALTERNATING CURRENTS.[1]

SINGLE-PHASE WORKING.

BY A. C. EBORALL.

The desirability of single-phase working for long-distance lines is self-evident, assuming that suitable motors are available. As the whole question turns upon the motors, it is now proposed to consider very briefly the various types of single-phase motors at present available; these types, apart from synchronous motors, are as follows:

1. Pure induction motors.
2. Series motors (Lamme, Finzi).
3. Repulsion induction motors (E. Arnold, Deri, Schuler).
4. Repulsion series motors (Latour, Eichberg-Winter).

The first-mentioned class of single-phase motors can be dismissed in a few words, as they can not be directly applied to electric traction purposes. Their efficiency and power-factor are less than is the case with the corresponding three-phase motors, their speed can not be regulated within commercial limits, their overload capacity is relatively small, and their starting performance is indifferent. The best that can be done in the latter respect, under favorable conditions with regard to frequency, is full load torque with one and three-quarters full load current—this with the help of a rotor resistance and a phase-splitting arrangement. Such motors could, therefore, only be used indirectly as far as electric traction work is concerned, although they possess the advantage (unlike the motors of the other three classes) of being without commutators.

B. J. Arnold has proposed to utilize such motors for traction purposes, with the help of an air compressor on the car, the object of the latter being to get over the starting difficulties, as well as those of speed regulation; the motor is always running on load, this consisting of the car and the compressor, or the latter alone, as the case may be. The Oerlikon Company, on the other hand, has suggested the use of single-phase induction motors in connection with heavy locomotive work, the motor working from a single overhead conductor at 15,000 volts, and forming part of a direct-current motor-generator combination carried by the locomotive, which supplies current to separately excited direct-current motors on the car axles. Although a certain amount of experimental work has been done in connection with each of these suggestions, it is hardly likely that such methods of working will come into general use.

The single-phase motors comprised in the second class are what used to be known a good many years ago as "laminated field" motors; before the advent of the single-phase induction motor quite a number were built in this country for the 83 and 100-cycle supply circuits then in existence. At that time they were built in very nearly the same way as the corresponding direct-current series motors, the principal difference in the design being the substitution of a laminated field structure for the standard cast or wrought-iron field frame. Such motors possessed every fault it is possible for a commutator motor to have—low efficiency, overheating and bad sparking being the worst—while being abnormally heavy for their output, mainly on account of their very low power-factor.

After remaining in the background practically since 1893, these motors have recently reappeared as possible railway motors. By reducing the frequency to 15—20 cycles (and with the help of sundry auxiliary devices, which have been more or less well known for years), aided by careful designing, a very good imitation of the direct-current series motor has been obtained, which is likely to come to the front in the future. Up to the present, as far as the author is aware, by far the best results have been attained with these series motors by Dr. Finzi.

The following are the principal difficulties connected with the design of single-phase series motors, together with the methods which are adopted in order to get over them:

1. Sparking—The coils which are short-circuited as the commutator segments, to which they are connected, pass under a brush, become the seat of very heavy induced currents, these coils being cut by the alternating field flux. These heavy short-circuit currents, being interrupted when the segments leave the brushes, cause heavy sparking; moreover, they tend to demagnetize the field system, and also waste energy in the short-circuited coils, brushes, etc.

The remedy is to connect the armature coils to the commutator by means of nickeline or other resistance strips (Finzi), or to employ a Weston winding on the armature (two independent windings alternately in circuit), to employ the proper width and quality of brush and to reduce the frequency.

2. Relatively Low Efficiency—This is due to the fact that both the iron and copper losses are considerably more than in the corresponding direct-current motor or induction motor. In the latter not much more than half the total weight of laminated iron is traversed by a flux of the full frequency (at speeds near synchronism), while for the case of the series motor the entire weight of active iron comes into consideration. Again, owing to the extra losses in the commutator connections, brushes, etc., and to the rather low power-factor at heavy currents, the copper losses are increased.

A reduction in the frequency improves matters.

3. Low Power-factor at Heavy Currents—Armature Reaction—The field and armature windings in series offer an impedance to the alternating current traversing them, and the greater the value of this current the more it lags behind the supply pressure—in other words, the worse the power-factor. The latter, in fact, falls from a high value at light loads to zero at standstill. As far as the field system is concerned, the only remedy is to reduce the frequency as much as possible, but with regard to the armature, seeing that it is the armature flux that causes not only the inductive electromotive force in the armature, but a reaction on the field system as well, it is advisable to reduce it to a minimum. This can be done either with the help of damping coils (Stanley) or by saturating the pole shoes (Lamme), or by dividing the poles in the axial direction by means of slits (Finzi). The first-mentioned arrangement tends to wipe out the armature flux altogether, and thus to get rid of field distortion and armature reactance; the second and third arrangements tend to reduce the armature flux in amount. As far as the inductive electromotive force of the armature winding is concerned, this decreases with the frequency.

It will be seen from the above that the real remedy for nearly all the troubles consists in lowering the frequency as much as possible, which, as already stated, is what is being done by the present constructors of these motors. The only disadvantage of this, as far as railway work is concerned, lies in the more costly nature of the generators and transformers; from the point of view of the inductive drop in the rail return, it is, of course, directly beneficial.

For the rest, the alternating-current series motor has speed, torque, and other characteristic curves generally similar to

[1] Excerpt of paper read before the Manchester local section of the British Institution of Electrical Engineers, December 15, 1903.

those of the direct-current series motor, except that the maximum values of the current and torque occur at a point which is relatively much nearer to the normal values.

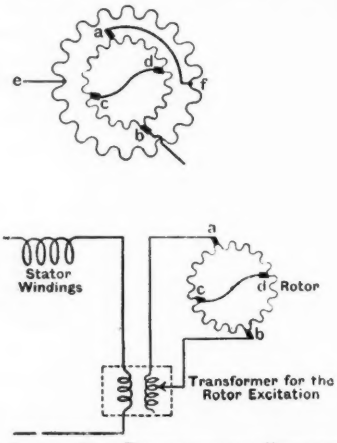
Railway motors of this type necessitate step-down transformers being carried on the car, as they can only be worked at low pressures; the speed control is affected by varying the transformation ratio and is hence very economical, this feature of the motor tending to compensate for its relatively lower efficiency.

The motors of the third class are mixed action motors; they start as repulsion motors, and after a certain speed has been attained, all the segments of the commutators are short-circuited, and they continue to run as induction motors. The type originated with Arnold, under whose patents the Wagner company, of America, has built many motors for ordinary industrial purposes, but as the Schuler motor is the best representative of the class, it will suffice to refer to it in particular here.

The characteristic features of the pure repulsion motor are its good starting performance and poor running performance. The efficiency and power-factor are both low, and for a given output the motor is relatively very heavy. On account of this, and especially in view of the fact that the change can be readily effected, it was but natural to change it into a pure induction motor at or near normal speed, because near synchronism the single-phase induction motor operates at its best. Arnold does this by short-circuiting the commutator segments by a centrifugal device (and raising the brushes simultaneously), while Deri does it by altering the number of stator poles in a similar manner. In both cases the conversion is suddenly performed and accompanied by undesirable current fluctuations; there is, moreover, a want of flexibility about it, which puts such motors out of the question as far as traction work is concerned.

In the Schuler motor, however, the transition from repulsion to induction motor is almost imperceptible, as it is effected with the help of slip rings and a star-connected rotor resistance, through which the rotor windings are gradually short-circuited. The commutator brushes remain short-circuited, and more or less current passes through them, in accordance with the manipulation of the resistance; at normal speed practically no current passes through them, as the rotor windings are, at this speed, completely short-circuited at the slip rings. At speeds intermediate between standstill and synchronous speed, part of the rotor current passes through the short-circuited commutator brushes and part through the rotor resistances; under these conditions the rotor is working partly as a repulsion motor, partly as an induction motor.

To sum up, the Schuler motor presents the possibility of starting with a large torque without an excessive current consumption, and of speed regulation over a long range with smaller losses in the rotor resistances, than would be the case with the corresponding three-phase motor operating under similar conditions. Its efficiency, power-factor and overload capacity are, however, much inferior to the latter, while with regard to commutation, it is comparable with the series motor, and what has been said in connection with the commutation of the latter is equally applicable to it. It is thought that while the Schuler motor is exceedingly well worked out, and the best of its class, it



FIGS. 1a AND 1b.—DIAGRAMMATIC REPRESENTATIONS OF LATOUR AND WINTER-EICHBERG SINGLE-PHASE, REPULSION-SERIES, RAILWAY MOTORS.

will not find a place in single-phase traction work, or, any rate, that it will not take precedence of the pure series motor, or of the series repulsion motors referred to below; its sphere of utility is more likely to be in connection with elevator and similar work. At the same time, it must be pointed out that the addition of an efficient compensating arrangement to it, so that it would work, at a power-factor approaching unity over its whole range, would alter the situation; in any case, it has one advantage over the series motor—namely, that no step-down transformer is required. Its stator construction is that of a standard three-phase motor with one phase of the winding always out of use, and the limiting value of pressure would be the same. Its rotor, which in construction resembles the armature of a rotary converter, must always work at low pressure.

This ability to work directly at high pressure is a property also shared by the fourth class of single-phase motors—the Latour and Winter-Eichberg motors. These motors are partly repulsion motors, partly series motors, and are the most interesting, and perhaps also the most promising, single-phase motors that have yet been devised. They differ in two important respects from all other series or repulsion motors—the power-factor is nearly unity under all conditions of working, while the field flux is produced by the rotor instead of by the stator, the ampere turns of the latter being less than those of the former. In Fig. 1 (*a* and *b*) the Latour and Winter-Eichberg mixed action motors are respectively indicated in diagrammatic form, and, as will be noticed, there is no essential difference between them. Indeed, these designers seem to have reached practically the same point by different and independent paths. By supplying the commutators at constant pressure (if necessary, through a step-down transformer of suitable size) instead of variable pressure, as indicated in the figure, motors can be obtained the performance of which is analogous to that of direct-current shunt motors, and such motors would be applicable to ordinary industrial work, as Latour has pointed out.

The windings indicated in Fig. 1 (two-pole motors being represented for the sake of clearness) correspond to series-wound direct-current motors, and hence will be alone referred to in connection with the subject of electric traction. As far as constructional features are concerned, the stators of these motors are just like the stators of ordinary induction motors; Latour, however, prefers to distribute the winding all round the periphery to form a closed circuit, there being thus (in the two-pole motor) two parallel paths traversed by the single-phase current. The rotors are simply specially proportioned direct-current armatures with amply dimensioned commutators of many segments; these commutators have to be arranged to work at 200 volts between brushes, or less, which can be readily arranged for if the current transformer of Winter and Eichberg is provided.

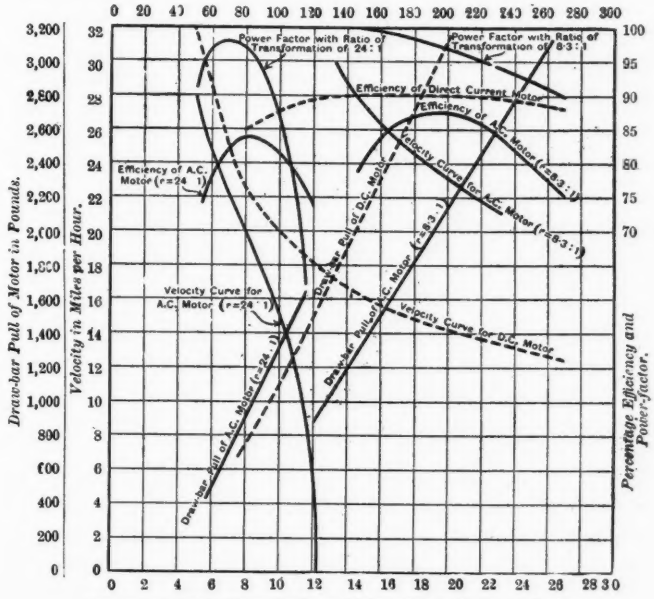
Consider, for instance, the motor of Fig. 1*a*, with the brushes *a b* removed, and the single-phase current traversing the stator only. A pure repulsion motor of favorable design would result, the characteristics of which would be (as Latour has shown) an excellent torque at starting, which decreases with the speed, together with perfect commutation at synchronous speed. As already indicated, however, the power-factor of such a re-

pulsion motor is very low, while, unless special arrangements are adopted, the motor sparks badly below synchronism. These defects disappear almost completely, however, directly the armature, with its short-circuited brushes *c d*, has current from the external circuit led into it (directly or indirectly) by means of the brushes *a b* placed at right angles to the brushes *c d*, which arrangement results in a repulsion series motor. The motor now has a power-factor of nearly unity at all loads, a starting torque equal to that of a three-phase motor, but not requiring resistances in order to obtain it, a possible speed variation over wide limits by varying the pressure at the brushes *a b*, and excellent commutation under all conditions at these brushes. Working under fixed conditions of supply, the speed and torque characteristics are generally similar to the corresponding characteristics of the direct-current series motor.

Briefly, the current C_1 passing through the rotor from outside by way of the brushes *a b* produces a rotor flux which, in conjunction with the rotation of the rotor in it, causes a current C_2 in quadrature with C_1 to flow through the rotor by way of the short-circuit brushes *c d*. The flux due to one component of the current C_2 cancels the stator flux, and thus renders the stator windings practically inductionless, and, moreover, by doing away with the stator flux, allows of perfect commutation at the brushes *a b*, as the heavy currents in the short-circuited coils, which would otherwise be caused by induction from the stator, are now no longer present. Again, the magnetic flux along *c d* forms, with the flux along *a b*, a resultant flux which rotates nearly synchronously with the rotor, and the latter, therefore, also becomes nearly inductionless, just as is the case with the rotor windings of an induction motor operating near synchronism. It would appear that the only serious difficulty with this motor is the commutation at the brushes *c d* at speeds below synchronism, but the difficulty can be got over perfectly well at frequencies of the order of twenty-five cycles, with the help of the means already alluded to.

As far as the author knows, the only difference between the above motor and that of Winter and Eichberg, apart from constructional details, is that in the latter motor the rotor is indirectly in series with the stator, as indicated in Fig. 1*b*. The use of the current transformer for supplying the brushes *a b* allows the stator to be worked at the full line pressure, no step-down transformer being, therefore, required on the car; at the same time the entire switching and speed control[1] is performed on the low-pressure side—that is to say, in the secondary circuit of the current transformer. Naturally, this arrangement lends itself well to multiple unit trains, the control being characterized by the absence of rheostatic losses and by the permanent connection of the various motors in parallel.

Current of Direct-Current Railway Motor at 500 Volts.


Power Factor with Ratio of Transformation of 24 : 1
Power Factor with Ratio of Transformation of 8·3 : 1
Efficiency of Direct Current Motor
Efficiency of A.C. Motor (r=8·3 : 1)
Efficiency of A.C. Motor (r=24 : 1)
Velocity Curve for A.C. Motor (r=8·3 : 1)
Velocity Curve for A.C. Motor (r=24 : 1)
Draw-bar Pull of A.C. Motor (r=8·3 : 1)
Draw-bar Pull of D.C. Motor
Draw-bar Pull of A.C. Motor (r=24 : 1)
Velocity Curve for D.C. Motor
Draw-bar Pull of A.C. Motor (r=24 : 1)
Draw-bar Pull in Pounds.
Velocity in Miles per Hour.
Percentage Efficiency and Power-factor.

Current of Single-Phase Railway Motor at 6,000 Volts, 25 Cycles.

FIG. 2.—CURVES OF 125 BRITISH HORSE-POWER WINTER-EICHBERG RAILWAY MOTOR, AND OF 125 BRITISH HORSE-POWER G. E. DIRECT-CURRENT RAILWAY MOTOR.

[1] The author has been unable to ascertain whether the whole of the speed regulation is effected by means of varying the transformation ratio of the transformer. It may quite well happen that supplementary arrangements are provided in the exciting circuits in order to get a means of fine regulation.

In Fig. 2 are given the results of some tests made by the Union company on an experimental coach fitted with motors of Messrs. Winter and Eichberg's design; this coach has been running since August on a short line near Berlin. The coach weighs fifty-two tons in running order, and is equipped with two motors of 125 British horse-power at 6,000 volts and twenty-five cycles; the weight of the entire electrical equipment is about six tons. In Fig. 2 are given also the curves (shown dotted) for the new 125 British horse-power motors on the Central London Railway[1] in order that a ready comparison may be made between a standard direct-current equipment of latest design and the single-phase equipment. For the latter it will be noticed that two sets of curves are given; these correspond to the maximum and minimum transformation ratios employed, and hence indicate the conditions prevailing at light and heavy loads, respectively. Between these limiting transformation ratios of 24 : 1 and 8.3 : 1 there are a number of others, the motor having similar characteristic curves for each. It will be seen that the efficiency of the single-phase motor is not much below that of the direct-current motor, while the speed control is equally flexible. The power-factor, moreover, is good over the whole range, while with regard to the commutation under different conditions the author has no information.

Whether one or other of these types of single-phase railway motor will eventually succeed in taking the place of the three-phase motors remains to be seen, but from what has been said above it will be recognized that a lot of good work has been done in this direction during the last year or so. The commercial application of such motors will depend largely upon the quality of the commutation under traction conditions, and with regard to this it must be borne in mind that the difficulties are, and always will be, very much greater than with direct-current motors. But one thing is quite certain—what with the new type of compounded alternators, the compensated three-phase motors and the various new single-phase motors, electrical engineers will have to reckon with the commutator in alternating-current machinery, and some modification of certain ideas at present held may confidently be expected in the near future.

Stockholm's electric tramways, now in construction, are to be ready for use early this year. The tenders accepted for the new lines were made by Swedish and German contractors in combination. The American bidders were unsuccessful in securing the contracts. The amount to be expended in this work is about 3,000,000 kronor ($795,000). Several other cities in Sweden—Gefle, Malmo, Norrköping, Sundsvall and others—are contemplating changing their street railway lines from horse-power to electric power.

[1] "The Central London Railway," by H. F. Parshall, E. Parry and W. Casson. *Traction and Transmission*, vol. vii.

NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CLXXIX—ON USING LIGHT OF SHORT WAVES FOR PRODUCING CHARGED PARTICLES, SIMILAR TO RADIUM AND CATHODE RAYS, FOR THERAPEUTIC PURPOSES.

Soon after the Curies discovered radium, experiments were made on animals with a salt of radium and briefly mentioned in these notes, the radiations being recommended for treating skin diseases. These recommendations have been adopted by others and radium has proved to have the therapeutic properties attributed to it. It is customary to consider that the alpha and beta rays of radium are charged particles and that the gamma rays are of the nature of X-light, but knowing of no experiments which indicate the gamma rays are anything but particles, they are here considered to be material particles, and the therapeutic properties of radium to be due to charged particles instead of as with X-light to ether waves. On this account and because radium is expensive a simple way of producing charged particles for use in therapeutics may be interesting. The method is new in therapeutics, though founded on an observation of Lenard, to whom also we owe the discovery of the so-called Rœntgen rays. One method of applying the idea is given as an example. Place the patient on an insulated platform connected with the positive terminal of an electric generator, which is producing a so-called unidirectional current of high voltage. He is then charged to a high potential. From the terminals of a source of high-voltage electricity attach wires to the sides of an enclosed portable spark-gap arranged to allow terminals of different metals to be used, the spark-gap being provided with an insulating handle to permit the source of light to be brought near any part of the patient. Adjust the spark-gap to give the maximum amount of short ether waves. Negatively charged particles will then be sent off through an opening in the case. They can be made to impinge on any part of the patient by bringing the spark-gap into a suitable position. As the particles penetrate several centimetres of air, near contact with the skin is not necessary though as the strength of the effect varies roughly as the distance, time is saved by having the distance short. The object of having terminals of different metals is to take advantage of any effect from the minute particles of metal that are thrown off. This method of producing negatively charged particles is applicable to the same diseases as are the negatively charged particles from radium. It is a convenient method of treating some skin diseases either alone or in connection to the short ether waves recommended in an earlier note and called derma rays on account of their good effect on the skin. Both of these methods have been tested on animals and to a less extent on man during the course of the experiments, a few of which have been mentioned in this series of notes.

NOTE CLXXX—WHY SHOULD SUCH DISSIMILAR AGENTS AS ETHER WAVES AND CHARGED PARTICLES SHOW SIMILAR CURATIVE POWERS?

It is generally known that X-light, usually supposed to be a motion of the ether, has therapeutic properties. It is less well known, though proved by experiment, that other ether waves originating in a vacuum tube and called derma rays have similar properties. It is generally known that radium, which gives off charged particles, has therapeutic properties. It is less known, though proved by experiment, that charged particles given off from a negatively charged body illuminated by ultra violet light have similar properties.

At present ether waves and charged particles appear dissimilar.

When similar results are produced by dissimilar agents the philosophical mind seeks the reason.

In the case of the similar therapeutic properties of ether waves and charged particles, may not the results be due to a power possessed in common of producing ions? When the molecules of the human body are equally ionized or broken, may not the results be similar though the active agents are unlike?

This theory, which has been used in experiments, some of which have been mentioned in these notes, appears to apply also to therapeutic results obtained from longer ether waves and charged particles from other sources in general use in electrotherapeutics, and therefore it may be a useful generalization to be used in investigation.

Sources of Energy and Their Importance.

The development of the human race is dependent not alone upon a supply of food but upon a supply of energy in available forms. Heat and mechanical energy are absolutely essential to man. The chief source of the energy that comes into play is fuel. We are primarily dependent upon the coal supply for the continuation of the activities of man. Without this, unless something is to take its place, man is doomed. Unless by means of scientific investigation man is taught new methods of rendering the world's store of energy available for the production of heat and of motion, the age of the human race is measured by the extent of the supply of coal and other forms of fuel. Plainly, as the demand for land for the production of foodstuffs increases, the amount available for the production of wood must decrease, so that wood need not be taken into account for the future. In regard to oil, our knowledge is not sufficient to enable us to make predictions of any value. If one of the theories now held in regard to the source of petroleum should prove to be correct, the world would find much consolation in it. According to this theory petroleum is not likely to be exhausted, for it is constantly being formed by the action of water upon carbides that in all probability exist in practically unlimited quantity in the interior of the earth. If this be true, then the problem of supplying energy may be reduced to one of transportation of oil. But given a supply of oil and, of course, the problem of transportation is solved.

What are the other practical sources of energy? The most important is the fall of water. This is being utilized more and more year by year since the methods of producing electric currents by means of the dynamo have been worked out. There is plainly much to be learned before the energy made available in the immediate neighborhood of the waterfall can be transported long distances economically, but advances are being made in this line, and already factories that have hitherto been dependent upon coal are making use of the energy derived from waterfalls. The more rapidly these advances take place the less will be the demand for coal, and if there were only enough waterfalls conveniently situated, there would be no difficulty in furnishing all the energy needed by man for heat or for motion.—*Excerpt from address of the retiring president, Dr. Ira Remsen, before the American Society for the Advancement of Science.*

National Electric Light Association.

One of the interesting portions of the volume of transactions which the National Electric Light Association is about to issue is the report, with illustrations in color, on decorative and sign lighting. Mr. Arthur Williams, the reporter on this subject, has been appointed to take up the matter again this year in a second report, and proposes to handle the subject in a somewhat different manner, adding to the illustrations the ideas and opinions of central station men concerning advertising signs, and selecting instances in which decorative lighting of that character has been productive of increased trade and revenue to the users.

INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY—VIII.

NOTES ON PROGRESS IN EUROPE AND AMERICA.

BY JOHN B. C. KERSHAW.

Nickel.

In continuation of the note upon nickel, published in the ELECTRICAL REVIEW of December 19, 1903, the following summary of a report upon the present position of the electrolytic nickel industry in the United States by Professor Haber will be read with interest. This authority states that the experimental trials with the processes of Hoeffner, Frasch and Ulke have led to no industrial results, and that only the Browne process can be considered of practical value. The success of this process was established at Cleveland by the daily production of 454 kilogrammes of pure nickel, over a period of some years. The plant was shut down in 1902 by the "Nickel Trust," which had obtained control of this, and many other nickel smelting and refining works, not because the process was considered to have failed, but because at that date the erection of a large refining works—for operation of the Browne process, at some more convenient centre—was under discussion. This project is still unrealized, however, and the position is somewhat complicated by the fact that the "Nickel Trust" has also obtained control of the refining works, using the old Orford (tops and bottoms) refining process; and at present this wholly metallurgical process is somewhat cheaper to operate than the electrolytic process. The nickel produced by the Orford process is sufficiently pure for use in steel manufacture, and therefore there is little inducement for the "Nickel Trust" to erect extensive electrolytic refining works. (This confirms the statement of the writer, published in the previous note.) In closing his review of the position of the nickel industry in the United States, Professor Haber draws attention to the importance of maintaining pure solutions in the baths or vats for the electrolytic deposition of nickel, and of metals generally. The failure to recognize this, as an essential condition of success, for all electrometallurgical processes in which the electrolyte is an aqueous solution of a salt of the metal, has caused many inventors to court disaster. In Haber's words, "Everything can be accomplished with pure solutions, nothing with foul solutions," and the absolute failure of more than one electrolytic process for metal extraction in recent times can be traced to the neglect of the inventor to fulfil this fundamental principle of success. This neglect has been especially evident in the electrolytic nickel, copper and zinc extraction processes.

Nitric Acid from the Air.

Professor Haber in the report upon electrochemistry in the United States, referred to in the previous note, has ventured some criticism upon the Bradley & Lovejoy process for fixing the nitrogen of the air, as worked by the Atmospheric Products Company at Niagara Falls. Some details of this process were given in the writer's note, published in the ELECTRICAL REVIEW of February 21, 1903. Haber states that he was disappointed with the stage of development in which he found this process, and in his opinion the plant at Niagara must still be regarded as experimental in character. He doubts whether acid stronger than fifty-five per cent HNO_3 can be made without concentration by the Bradley & Lovejoy process; and if this surmise should prove correct, he is afraid that the cost of producing concentrated acid will prove prohibitive. Volney is another critic whose judgment of the process is somewhat unfavorable. According to this investigator (who has published his opinion in the Transactions of the American Electrochemical Society), the production of nitric acid and of nitrates on the large scale by the spark discharge is impossible, since decomposition of the products already formed is brought about by the same agency. It may be pointed out, however, that the same difficulty exists in the very similar process for the production of ozone by the silent electric discharge, but that this difficulty has not prevented the electrostatic method obtaining a limited success as an industrial process. The conditions obtaining in the nitric acid industry are, it may be admitted, less favorable, for nitric acid is already produced by chemical methods in large amounts, and the new electrostatic process for obtaining it from the air will have to compete with an old and well-established industry. The success or otherwise of the Bradley & Lovejoy process is therefore largely a question of comparative cost; and possibly Haber is correct in forecasting failure, unless an acid of higher test than fifty-five per cent can be obtained without recourse to the ordinary methods of concentration.

Whether the heat developed during the sparking in the Bradley & Lovejoy apparatus could be utilized for concentrating the final product is a point worth Messrs. Bradley & Lovejoy's attention, since such an application might spell the difference between industrial success and failure of the process.

A similar electrostatic nitric acid process, supposed to be that worked out by two Polish chemists, is about to receive trial in Europe, at the works of the Soc. de l'Acide Nitrique at Fribourg. The yield by this process is stated to be fifty-two to fifty-five grammes HNO_3 per kilowatt-hour, when using air, and higher with pure oxygen.

New Uses for Aluminum.

The increased application of aluminum in lithography has already been referred to in this series of notes (see ELECTRICAL REVIEW, December 19, 1903). Two other branches of industry in which the use of the new metal may be expected to increase rapidly are metallurgy and explosives. In each of these the application depends upon the high affinity of aluminum for oxygen, and upon the high temperature attained when the metal in the form of powder is oxidized or burnt, under favorable conditions.

This property of aluminum has long been known, and Vautin attempted to apply it to industrial use in England for heat generation more than ten years ago (in 1892-1893). He failed, however, to regulate the reaction so as to render it of practical utility, and to Dr. Goldschmidt, of Essen, belongs the honor of applying the high affinity of aluminum for oxygen to industrial purposes. Goldschmidt has achieved this result by mixing the aluminum powder with ferric oxide, in the necessary proportion, and by putting this mixture (with special detonators) on the market under the trade name of "thermit."

Goldschmidt worked out the details of this method in the years 1897 and 1898, and, in conjunction with Vautin, read a paper upon it before the London section of the Society of Chemical Industry, in June, 1898. The writer was present at Burlington House on that occasion, and saw Dr. Goldschmidt carry out several experiments, first in the meeting room and then in the Burlington House enclosure. It is only recently, however, that the application has developed rapidly and become of considerable industrial importance. Many illustrated articles have been published on "alumino-thermics" in American journals this past year, and it is unnecessary to describe the process here. It will suffice to say that the consumption of "thermit" for rail-bonding, ship repairs and foundry use is rapidly increasing, and Dr. Goldschmidt estimates the consumption of powdered aluminum for manufacture of this product in 1903 to amount to 100 tons.

The other application of aluminum referred to above is in the manufacture of a new explosive called "ammonal," protected by patents granted to Fuhrer, of Vienna. In this explosive the calorific effect of the combustion of aluminum in oxygen is used to raise the temperature of the gases produced by the decomposition of ammonium nitrate to a very high point, and thus to intensify the explosive effect. The ingredients of this new explosive are: carbon, ammonium nitrate, and aluminum powder, and a twenty-gramme charge is stated to yield 2,000 cubic centimetres of gas on firing. A factory is about to be erected in Europe for its manufacture, and it is expected that large amounts of aluminum will be required.

The Chèvres Hydraulic Station near Geneva.

By B. F. Hirschauer.

THE city of Geneva and the surrounding district are supplied with light and power from a hydraulic station which is established on the Rhone not far from the point where it flows from lake Leman. The Chèvres plant is one of the largest and best equipped in Europe. At the start it was equipped with five turbine units, but at present the number has been increased to fifteen, owing to the demand for current. The large station building and the dam across the Rhone will be observed in one of the illustrations. Most of the current from the Chèvres plant is sent over a high-tension line to Geneva where it is transformed in different substations to supply the lighting and tramway circuits.

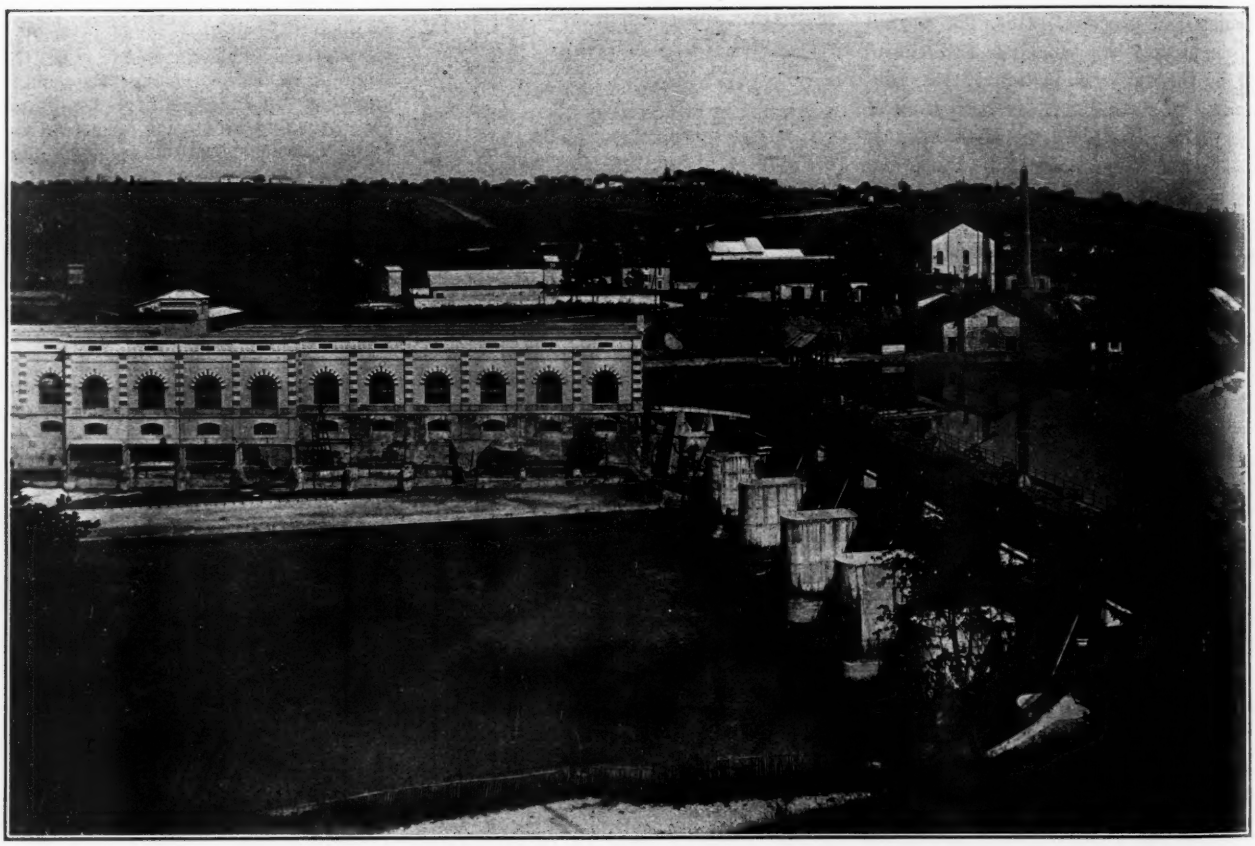


FIG. 1.—SHOWING CHÈVRES HYDROELECTRIC STATION AND THE DAM OVER THE RIVER RHONE, SWITZERLAND.

The dam is formed of a series of seven piers which form a line across the river between the station building and the bank, as will be observed in the illustration (Fig. 1). In the spaces between the piers are placed the six main gates of the dam, which slide in grooves and can be raised or lowered by a hoisting apparatus placed above. The gates have an opening of thirty-three feet. The piers, which are built of cement beton, are protected from the action of the water by an iron plate covering three millimetres thick at their lower part. The gates of the dam are formed of riveted iron plate and are reenforced at the rear side by a series of metallic girders of parabolic form which are applied against the gate from top to bottom. The gates are suspended by four steel cables of 0.330 metres diameter, using two cables at each end. The cables pass up to the hoisting apparatus, which is located on the superstructure. To provide for the raising and lowering of the gates, a bridge formed of timbers has been placed across the top of the piers, as will be noticed, running the whole length of the dam. Each of the gates is provided with a set of hoisting pulleys at either end, which receive the cables coming from below. The two sets of pulleys are operated at the same time from a windlass which is placed in the centre, which allows one man to carry out the manœuvre of the gate. On the other side of the station building is a long canal or basin from which the water enters the masonry conduits leading to the turbines.

The Chèvres station is provided with fifteen main turbine groups which form a continuous line from one end of the building to the other. Besides the main turbines, there are a number of smaller sets which operate the exciters, pumps and other apparatus of the plant. The turbines, like the main dynamo groups, were designed and executed at two different periods. The turbines which were installed in the first part of the plant are five in number, operating at a speed of eighty revolutions per minute, while the remaining ten turbines work at a considerably higher speed, or 120 revolutions.

The turbines of the first group have been built on the double system by Escher Wyss & Company, one of the leading Swiss firms. The considerable difference in the fall which occurs at different seasons of the year (fifteen feet in summer and twenty-eight feet in winter) is one factor which determined the choice of the turbines, and it was also desired to obtain the highest speeds possible while at the same time using large units of from 800 to 1,200 horse-power. These

two conditions led to the choice of a type of double turbine which should fulfil the requirements. Each unit is formed of two turbines which are mounted one above the other on the same shaft. The lower wheel is designed to work at periods of low water, while in times of high water both turbines work together. By this combination each group is capable of furnishing from 800 to 1,200 horse-power, and the double arrangement makes it possible to secure a nearly uniform speed of eighty revolutions per minute.

To carry out the regulation and secure a variable delivery of water, a very efficient system has been adopted. Around the periphery of the turbine is a series of orifices for the water entry, which can be more or less closed by a revolving gate consisting of a ring which surrounds the turbine and provided with corresponding openings. The ring is turned in one direction or the other by means of an automatic regulating apparatus. This device will be observed in the general view of the interior (Fig. 2) and is mounted in front of each of the main alternator groups. The upper and lower turbines are each in separate connection with the regulator. The device consists of a speed governor of the centrifugal type which is driven from the main turbine shaft, combined with a hydraulic motor or distributor. The governor controls the distributor and causes it to transmit a movement by means of shafts and gearing to the revolving gate of the turbine, opening or closing it to the desired point. This action is especially brought to bear at the time of starting. At first the lower turbine is opened up and then the upper one follows automatically. On stopping, the reverse action takes place. The hydraulic distributor consists of three cylinders which are mounted on a common foundation plate. The pistons of these cylinders work under a pressure of fifteen atmospheres, which is produced by a special oil pump. The pistons work the mechanism for opening or closing the turbines. The oil pump serves at the same time for supplying the bearings of the different machines in the station. The tests which have been made upon this system of regulation show that it is very efficient in keeping the speed of the machines constant. In the case of a variation of the load to the amount of 300 horse-power, the speed fell momentarily by three per cent, and then rose to the normal. In another test, where the load was suddenly thrown off the machines, the speed did not vary more than three to five per cent and came back to the normal in four or five seconds under the action of the regulator.

In the ten following groups the construction has been somewhat different. The sectional view (Fig. 3) shows the general arrangement of the water system, with the turbines and dynamos. While the water comes to the first five wheels from the exterior, the new arrangement causes it to enter at the interior of the turbine and allows of obtaining a considerably higher speed. Each turbine group consists, like the former, of two superposed wheels, each one having two series of stationary directing vanes. The two wheels are disposed so as to work in seasons of high and low water. During the periods of high water (twenty-eight-foot head) the lower wheel works alone, but in the summer season, where the fall is only fifteen feet, both turbines are operated together. Five of the new groups are specially arranged to work on the

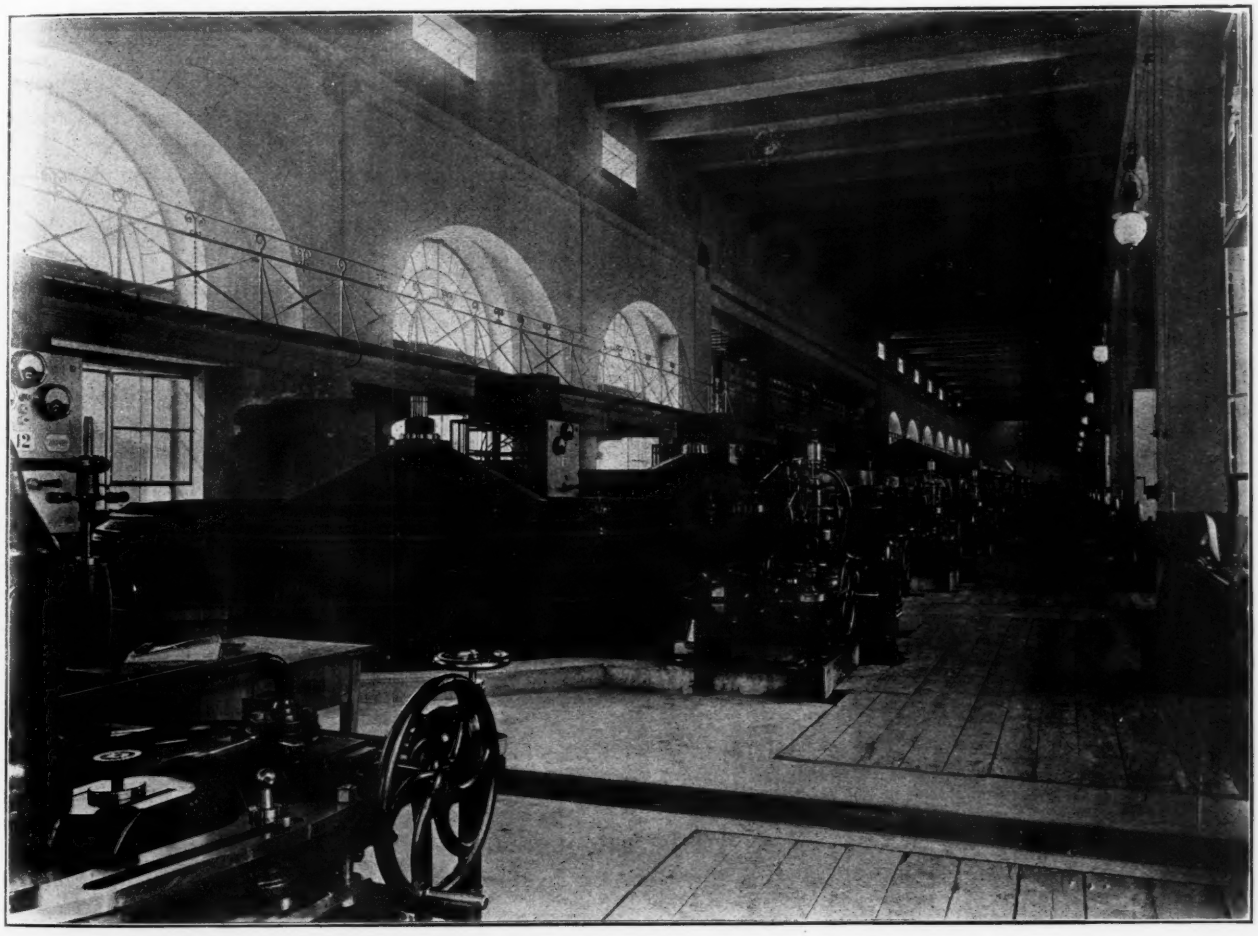


FIG. 2.—INTERIOR VIEW OF CHÈVRES HYDROELECTRIC STATION, SWITZERLAND.

twenty-eight-foot fall during the winter; on the contrary, the five other groups have their wheels adjusted so as to work during low-water periods. Under these conditions the groups will give an output of 850 to 1,200 horse-power at a speed of 120 revolutions per minute. The output of the fall varies according to the season, from 4,000 to 7,000 gallons per second. These turbines are provided with a system of regulation which is similar to the former.

One of the engravings (Fig. 2) shows

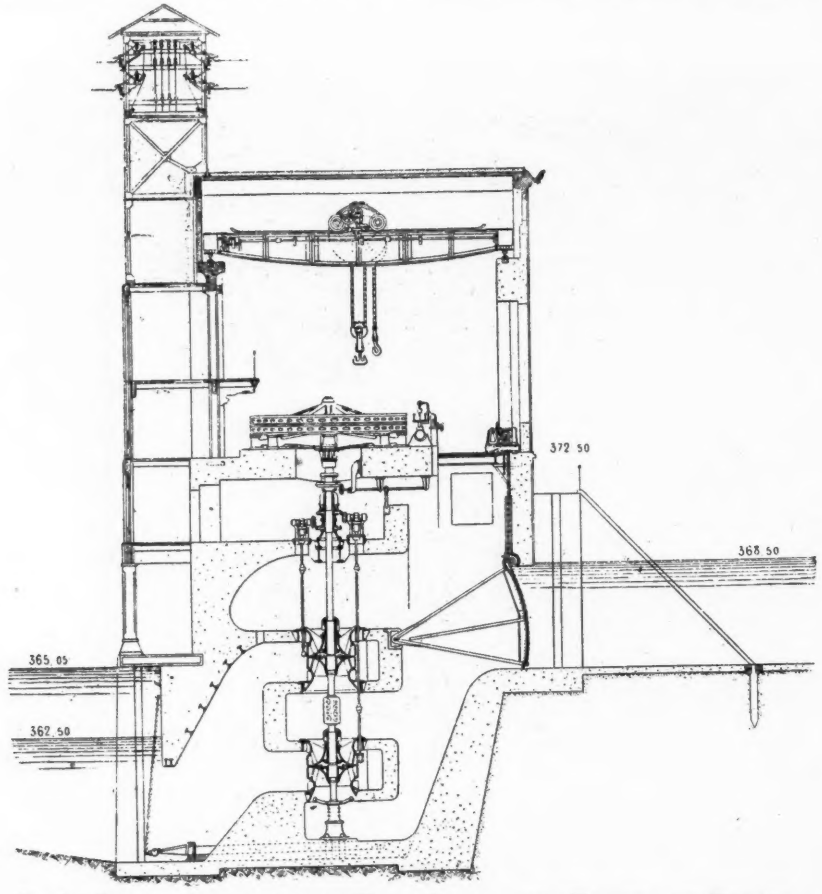


FIG. 8.—GENERAL ARRANGEMENT OF WATER SYSTEMS, WITH TURBINES AND DYNAMOS.

a view of the main floor of the Chèvres plant. The alternators, each of which is disposed above one of the main turbines, form a long line which extends the whole length of the building. In front of the alternators are the speed regulators and on the right-hand side will be noticed the mechanism for raising and lowering the main water-gates. There are fifteen main dynamo groups now installed in the plant, comprising fourteen alternators, and one large direct-current machine for electrolytic work. As in the case of the turbines, these machines were installed during two different periods and include two types of alternators. The first part of the plant contained five alternators of the Thury pattern, which were furnished by the Compagnie L'Industrie Electrique, of Geneva, in 1895 and 1896. As this number proved insufficient for the increasing demands upon the station for light and power, mainly owing to the development of the traction lines in the city of Geneva, it was decided to increase it to more than double its original capacity. The second series included six biphase alternators which were installed in 1898 and 1899. These machines were supplied by Brown, Boveri & Company. Lastly, the four Thury machines which complete the present plant were installed by the first-named company.

The five alternators which form the first part of the station are built to give 1,200 horse-power each and operate normally on a tension of 2,750 volts. These machines work at eighty revolutions per minute upon the slow-speed turbines mentioned above. This corresponds to a frequency of forty-five cycles. The alternators are of the internal revolving field and fixed armature type, with the field mounted horizontally on the turbine shaft. The two armature windings are disposed so as to be coupled in series when desired and in this case they will deliver monophase current at 5,500 volts, otherwise they furnish biphase current. The efficiency of these machines was found on the tests to be ninety-three per cent at full load, this corresponding to an output of 150 amperes per phase at 2,750 volts.

The current for exciting the fields of these machines, as well as the remaining alternators of the station, is furnished by a set of special generators, each of which is driven from a smaller upright turbine. The exciting current which is required at full load is forty-five amperes for each half of the field. The total weight of the alternators is seventy tons of which the revolving field represents a weight of twelve tons. The two turbines together with the vertical shaft weigh about twelve tons. As the vertical pressure of the water on the turbine amounts to twelve tons, it will be seen that the total weight which the lower pivot is obliged to support is no less than thirty-six tons.

Owing to this heavy load it was desired to use some method for relieving the lower pivot of part of the weight in order to avoid frictional losses, and this led to the adoption of a special form of pivot which uses hydraulic pressure to lift up the shaft. It is formed of two parallel plates, one of which is stationary and the other fixed to the shaft. The plates revolve one upon the other and one of them, the fixed plate, is provided with two concentric grooves or chambers which are in connection with the oil pressure system which supplies the speed regulators of the turbines. As the plates present a considerable surface the pressure which is exerted between them is sufficient to lift up the whole of the movable system, so that the latter rests upon a sheet of oil and turns with the minimum friction. The system is completed by an oil pressure gauge and a main gate valve for cutting off the oil supply. The oil after passing down and lubricating the main pivot is collected in a reservoir and is taken thence by pumps. After filtering, it is passed again into the main system.

The alternators of the second series are constructed on the same general lines as to exterior, but differ considerably in detail. These machines lie in the middle of the dynamo room, and two of them may be distinguished in the illustration as the second and third in the series. Each of these alternators is built to deliver 1,200 horse-power. The revolving part is mounted directly on the turbine shaft. Biphase current is produced at a frequency of forty-five cycles. The voltage of these machines is 5,500 or 2,750 volts according to the method of coupling the circuits, and each of the phases is formed of a separate and independent winding

which can be connected in series or parallel. The exciting current remains constant in this case.

The armature of these machines is formed of an outer circular casting which forms the fixed ring. Around the inner periphery is disposed the armature core. This is perforated to receive the wires forming the armature winding. The latter are specially insulated for high voltage. To suppress all chances of leakage to the mass, each of the holes is lined by a thick tube of insulating material which surrounds the winding. The inside of the armature ring is bored out so as to bring the surface nearly flush with the holes. This leaves but a very thin layer of iron above the winding. The exterior ring casting is provided with a set of radial arms which project inward toward the centre and carry the double bearing which supports the turbine shaft.

FIG. 4.—ONE OF THE NEW ALTERNATORS INSTALLED BY THE COMPAGNIE L'INDUSTRIE ELECTRIQUE.

The inner revolving field which the shaft carries has the form of a flattened cone and is provided with radial arms at the upper part, while the lower or circular portion serves as a support for the field coils. On the exterior of the rim is mounted a set of forty-six pole-pieces which carry the field coils. The air-gap is small. The conical form of support has been adapted so as to allow of raising the inner bearing to as high a point as possible and to bring it on a level with the pole-pieces. In this way the strains upon the revolving part which are due to magnetic action will have but little tendency to bend the shaft.

The remaining three alternators have been built by the Compagnie L'Industrie Electrique and are of a different type from the first set which the same company installed in the beginning of the station. One of these machines will be observed in the foreground of the general view. In Fig. 4 is a detailed view of the alternator complete, while Fig. 5 shows the internal revolving field and the method of placing the pole-pieces. After the first machines were installed it was found desirable to increase the speed from eighty revolutions per minute to 120 and accordingly the present machines were designed to operate at the latter speed. These machines have an outer fixed armature whose winding is laid in a series of grooves in the inner surface, while the field with the usual radial pole-pieces is carried upon the turbine shaft.

FIG. 5.—REVOLVING FIELD OF ONE OF THE NEW ALTERNATORS INSTALLED BY THE COMPAGNIE L'INDUSTRIE ELECTRIQUE.

The conical casting, which forms the base of the revolving field, carries forty-six pole-pieces upon its periphery. The conical part is formed of cast steel and the pole-pieces are built up of laminated iron. The movable part has a diameter of fifteen feet and a total weight of twenty-one tons. The whole machine, including the shaft, weighs about forty-four tons. The armature coils which are placed on the interior of the ring are lathe-wound and insulated with mica.

The coils are introduced into the slots by a high pressure. In these machines the winding is laid in slots instead of being passed through holes, as in the preceding type.

The remaining machine of the series, which is located in the extreme end of the dynamo room, is a direct-current generator which has been specially constructed for electrolytic work by the Compagnie L'Industrie Electrique. It is used to supply the electrochemical works of La Volta Company, which lie on the bank of the Rhone adjoining the Chèvres station. This machine, which has been designed by M. Thury, is a twelve-pole direct-current generator of the upright pattern and differs considerably from anything that has been built heretofore. It is intended to furnish a current of 4,000 amperes at 208 volts. The field casting, which is of ring form, carries four arms which project upward and toward the centre. These arms carry the upper bearing of the shaft. The field base of this machine is about ten feet. The armature, of the drum pattern, is carried on the turbine shaft. Above the armature is mounted a large commutator which has an exceptional length and carries two sets of twelve brush-holders, or twenty-four in all. Carbon brushes are used and the diameter of the commutator is three feet six inches. The armature winding is formed of bars which are insulated with shellac and mica and laid in grooves. The latter are only partially opened up at the surface, so that they retain the bars without the use of binding wire. The dynamo is provided with a hand brake by which its movement can be stopped within a very short time. The brake consists of a band which works around a drum carried on the main shaft and it is thrown into play by a hand wheel at the side of the machine.

The fields of the different alternators are supplied from the main exciter circuit, which is fed from three direct-current machines. The latter have been supplied by the Oerlikon Company, of Zurich. Each dynamo is mounted upon a separate vertical turbine. The exciters are built to furnish 115 volts and 750 amperes, and they operate at 150 revolutions per minute. They are of the six-pole type. The armatures are drum wound, using copper bars with varnished cloth and mica insulation, which are placed in slots in a laminated iron core. Each machine has six sets of three brushes.

PRELIMINARY EXPERIMENTS ON AIR FRICTION.[1]

BY W. ODELL, A. R. C. SC.

The tendency now-a-days to increase the speed of many classes of machinery has resulted in several forces, formerly negligible, becoming important. For instance, want of balance of the moving parts, which did not have to be considered in a beam engine revolving under fifty times a minute, has become the crux of engine design now that 400 revolutions per minute is a common speed, both afloat and ashore; and with the far higher speeds which the steam turbine is bringing in, forced lubrication is becoming a necessity.

Among other effects of change in this direction, the loss of power due to the friction with the air of large rotating objects promises to become noticeable, and about two years ago my friend, Mr.

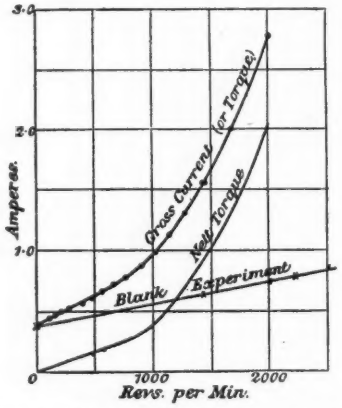


FIG. 1.—PRELIMINARY EXPERIMENTS ON AIR FRICTION.

W. Cramp, of the Central Technical College, suggested to me that I should try and get some figures as to the power thus wasted by dynamo armatures, flywheels and rotating bodies generally. Obviously it was best to start with the simplest form, and the following is an account of some attempts to measure the power required to keep a plane circular disc rotating.

FIRST EXPERIMENTS.

In my first experiments I used a pair of falling weights attached to threads wound on an axle of known diameter, to which a cardboard disc was fixed, and which was supported symmetrically on friction wheels. There was an arrangement for supplying extra weight at the start while speed was being got up, and then, by timing the intervals taken by the weights through two equal successive intervals, the constancy and magnitude of the speed could be ascertained, as well as the power employed. To eliminate solid friction, a cylinder of lead equal in weight to the disc was substituted for it, and while the sum of the weights on the driving threads was kept constant, they were made unequal, and wound against one another, so that the heavier had to

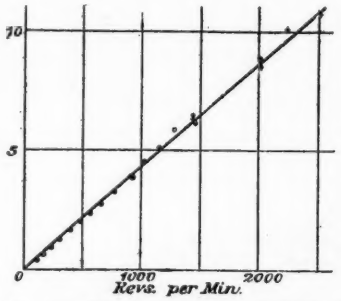


FIG. 2.—PRELIMINARY EXPERIMENTS ON AIR FRICTION.

raise the lighter, and the difference adjusted till the speed was the same as before.

As the force of the solid friction in this apparatus was exceedingly small, and any errors of observation tended to eliminate one another, this method is in some ways a very accurate one, especially for small speeds, and I may have to return to it in the future; but it is very tedious to carry out single-handed, and unless a great height is available for the fall of the weights, there is much difficulty in getting a constant speed, and the intervals of time are too short to measure accurately with an ordinary stop-watch.

Then Professor Perry suggested to me the use of an electric motor, taking the difference of the watts required to run it with and without a disc fixed to its shaft. This appeared a much more convenient plan, so I commenced a fresh series of experiments, which are described below.

DESCRIPTION OF APPARATUS.

The Motor—The motor was a two-pole, twelve-segment, ring armature, series-wound machine, marked "sixteen-volt Greenhalg patent." In these experiments the field was separately excited, and as about 1.8 amperes were required in the field windings, whose resistance was about 0.4 ohm, to saturate the magnets a potential difference of at least 0.85 volt was maintained across the field terminals by means either of three pairs of Daniell's cells or, when available, by a couple of two-volt accumulators in parallel through an adjustable resistance of manganin wire. By this means a constant field was ensured.

Counter—A revolution counter was attached to one end of the motor shaft by a piece of india-rubber tubing and was clamped firmly to a stand rigidly fixed with respect to the bed-plate of the motor, so that the alignment of counter and motor remained unaltered through each series of experiments.

Ammeter—The armature current was measured by a Stanley ammeter graduated to 0.1 between 0.30 and three amperes. It had not been made for scientific work; the graduations were too thick, and it was stronger at the upper end of the scale than at the lower.

Voltmeter—The electromotive force across the brushes was measured by a Weston portable standard instrument graduated to 0.05 up to five volts, or to 1 up to 100. These scales did not fit in with the pressures at which the motor

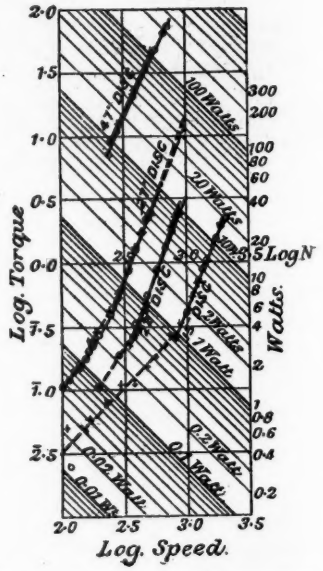


FIG. 3.—PRELIMINARY EXPERIMENTS ON AIR FRICTION.

worked, and the higher ones could be read with but a small degree of accuracy.

METHODS OF EXPERIMENTING.

When all connections were made and the field properly excited, a series of blank experiments was made. In each experiment, after the volts and amperes had become steady, they were noted, and the time taken by means of a stop-watch for some round number of revolutions to be made. From this the speed was calculated. Current was then plotted on a speed base, and the best straight line drawn through the plotted points. Taking the armature resistance as 0.8 ohm, the CR drop was subtracted from the volts observed at each speed, and the net volts thus obtained were also plotted on a speed base; this gave a straight line passing through the origin, whose equation was about

230 revolutions per minute = 1 net volt.

The experiments proper were then performed in an exactly similar manner

[1] Paper read before the British Association, Section G, at Southport, England. Slightly abridged and with a number of curves omitted.

after the disc had been fixed to a flange on the free end of the motor shaft. The volts were observed more as a check on the running of the motor than anything else, as the net-volt-speed curve should coincide in both series of experiments. The current-speed curve was plotted with the same axes as before.

Paper discs were used instead of cardboard ones, as the latter substance warped too badly.

FIFTEEN-INCH DISC.

The motor was first run light at five different speeds (including zero), and the current and net volts plotted separately on speed bases, and the best straight line drawn through each set of points (see Figs. 1 and 2).

The net-volt curve passed through the origin, and gave 231 revolutions per minute as being the equivalent of one useful volt. From this we may calculate that one ampere through the armature produced a torque of 0.366 inch-pound nearly.

A drawing-paper disc, 15.04 inches in diameter, was now attached and driven at various speeds. The first four columns of the table below give the figures observed.

Observed Volts.	Current.	Revolutions (by Counter).	Time in Seconds	Speed in Revolutions per Minute.	C R.	Net Volts
		Motor Light.				
..	.38		Just no motion			
11.5	.85	2000	62.2	2508	.63	10.8
10.85	.79	2400	64.6	2230	.63	10.2
9.15	.74	2000	59.8	2007	.59	8.56
6.8	.64	1500	62.8	1433	.51	6.3
		Motor with 15-In. Disc on Main Shaft.				
11.1	2.78	2000	58.8	2004	2.22	8.9
9.0	2.00	2000	71.3	1683	1.6	7.4
7.7	1.56	1500	63	1429	1.35	6.45
7.4	1.56	1500	62.2	1448	1.25	6.15
6.9	1.30	1500	70.6	1275	1.04	5.86
6.0	1.12	1200	62.8	1146	.9	5.1
5.8	.99	1000	58.8	1021	.79	4.5
4.6	.87	1000	66.6	901	.7	3.9
4.59	.87	1000	66.4	903	.7	3.89
3.90	.78	1000	78	769	.62	3.28
3.37	.72	800	72.6	661	.58	2.79
2.90	.66	600	63.8	565	.53	2.37
2.53	.61	500	62.2	482	.49	2.03
2.11	.56	400	60.8	395	.45	1.66
1.70	.54	300	59	305	.43	1.27
1.35	.50	300	77.6	232	.40	.95
1.05	.47	200	70.8	169½	.38	.67
.80	.45	150	79.8	113	.36	.44

The volt-speed curve is the same as when unloaded, so that the value of one ampere in inch-pounds of torque is the same. The current-speed curve is given in Fig. 1; its shape is suggestive. Interpolating from the current-speed curve of the blank experiment and subtracting gives us the figures in columns 3 and 6 above for net torque; they are also plotted in Fig. 1.

Gross Current.	Current from Blank Experiment Curve.	Net Torque (1 Ampere = .366 Lb. Inches.)	Log. Net Torque.	Log. Speed.	Speed.
		amperes			r. p. m.
2.78	.74	2.04	0.3096	3.302	2004
2.00	.685	1.315	0.119	3.226	1683
1.56	.64	.92	1.964	3.158	1440
1.30	.61	.69	1.839	3.1055	1275
1.12	.585	.535	1.728	3.059	1146
.99	.57	.42	1.623	3.009	1021
		.31	1.491	2.954	902
.78	.515	.265	1.423	2.886	769
		.22	1.342	2.821	661
		.18	1.255	2.752	565
		.15	1.176	2.683	482
		.11	1.041	2.597	395
		.105	1.021	2.484	305
		.08	2.903	2.3655	232
		.06	2.778	2.230	170
		.05	2.699	2.053	113

Taking logs of columns 3 and 6 in the above table gave columns 4 and 5, which were plotted in Fig. 3, in which they are indicated by crosses (+) on the lowest of the curves. There is no mistaking the character of the locus of the points to the right of log. 900. It is a very good straight line, and its slope is about two and one-third—*i. e.*,

$$\log. T = 2.33 \text{ low. } \omega + c,$$

or

$$T = C\,\omega^{2.33}.$$

To the left of log. 900 the character of the locus changes very evidently, as might have been anticipated, perhaps, from a careful examination of the torque curve in Fig. 1. The exact nature of the low-speed locus is not so evident owing to the increase per cent of the errors owing to the torque being obtained by difference. Now the ordinary assumption about fluid friction is that for low speeds it follows a linear law; and that, unlike solid friction, it vanishes when the speed becomes indefinitely reduced, is common experience. So I have ventured to draw a straight line from the origin in Fig. 1 through the low-speed points of the net torque curve and a line at forty-five degrees through the corresponding logarithms in Fig. 3; and I think it will be agreed that it fits in as well as any other single locus would do. At any rate, we may provisionally conclude that at a certain speed a discontinuity occurs in the law connecting torque and speed, above which a higher law than the second power is followed.

To test this I repeated my experiments with this disc, examining the higher speeds more particularly. The results were plotted the same as before, and we got the following:

Gross Current.	Current from Blank Experiment Curve.	Net Torque (1 Ampere = .366 Pound-Inches).	Log. Net Torque.	Log. Speed.	Speed.
		amperes			r.p.m.
		.25	1.398	2.914	820
.96	.56	.40	1.602	3.000	1000
		.71	1.851	3.114	1300
1.49	.62	.86	1.935	3.146	1400
1.69	.65	1.04	0.017	3.176	1500
2.25	.70	1.55	0.190	3.255	1800
2.71	.735	1.975	0.296	3.301	2000
2.96	.75	2.21	0.344	3.322	2100
		.025	2.398	2.083	121

Columns 4 and 5 are plotted in Fig. 3, the points being marked with small circles (⊙), and they will be found to lie even more exactly on the line drawn through the earlier points than those points themselves. As they are all high speeds except the last, they give us no information about what occurs below the discontinuity; but it may be noted that whereas the torque of the slowest experiment of the first series came out higher than might have been expected, the value found here for 121 revolutions per minute is much lower.

TWENTY-TWO-INCH DISC.

The second disc tried was 21.82 inches across, and was of thinner, smoother drawing paper than the last. The net-volt-speed curve gives 231 revolutions per minute per volt, as before; the points for the slower loaded experiments come out a little higher. I take it that the commutator was dirty, and that the resistance was increased thereby across the brushes. The torque curve was not easy to draw completely, as, unfortunately, I had got no readings for speeds between 600 and 800 revolutions per minute. From the two ends of the curve the following numbers were obtained:

Gross Current.	Current from Blank Experiment Curve.	Net Torque (1 Ampere = .366 Lb. Inches.)	Log. Net Torque.	Log. Speed.	Speed.
		amperes			
.		.22	1 342	2.544	350
.	..	.27	1.431	2.602	400
1 07	.59	.48	1.681	2.699	500
1.48	.615	.865	1 937	2.778	600
2.54	.67	1.87	0.272	2.903	800
2.90	.69	2.21	0.344	2.929	850

Columns 4 and 5 will be found plotted in Fig. 3. Excepting the first, they lie very nearly on a straight line above the one drawn for the fifteen-inch disc. Its slope is 2.82.

A second series of experiments was performed with this disc, and the results plotted. An inspection of the points in the latter reveals one thing at once—the field weakened between the two parts of the series from 231 to about 240 revolutions per minute per volt, and that therefore the value of one ampere in pound-inches of torque had gone down in that ratio between the end of the blank experiments and the commencement of those with the disc. Consequently, before subtracting to get the net torque, it was necessary to increase the height of the loss line in the blank experiment by $\frac{9}{231}$ of its original height. This gave the following figures:

Gross Current.	Corrected Current from Blank Experiment Curve.	Net Torque (1 Ampere = 0 3525 l.b Inches)	Log Net Torque	Log Speed.	Speed.
		amperes			r p m.
..	..	105	1.021	2.301	200
.685	.495	.19	1 279	2.477	300
.84	.51	.33	1.519	2.602	400
..		.56	1.748	2.699	500
1.41	.535	.875	1 942	2.778	600
1.84	.55	1.29	0 110	2.845	700
2 325	.565	1.76	0.246	2.903	800
2.93	.58	2.40	0.380	2.954	900

The fourth and fifth columns are plotted in Fig. 3, the points being marked by a ring (⊙). The six upper points lie in a very good straight line, whose slope is 2.55. The discontinuity appears at the same speed as before (about 350 revolutions per minute), and it is noteworthy that below it the curve does not support the hypothesis mentioned above—that at lower speeds the torque is proportional to the speed.

TWENTY-SEVEN-INCH DISC.

The next disc was made of cartridge paper and measured 26.83 inches across. It weighed about four ounces; so to eliminate its effects on the solid friction of the apparatus, a drum of lead was placed, in the blank experiments, round the flange to which the disc would be subsequently fastened.

From the net-volt-speed curve in the blank experiment one volt stood for every 235 or 236 revolutions per minute—*i. e.*, one ampere through the armature was producing a torque of 0.36 pound-inch. The points for the machine loaded come very slightly lower. This was probably due to the figure for the armature resistance being too high. CR is over sixty per cent of the net volts every time, and sometimes rises to 110 per cent, so that an error of five per cent in R would produce an equal error in the net-volts.

From the two-current-speed curves the following figures were obtained:

Net Torque (1 amp. = 36 lb.-in.)	Log. Net Torque.	Log. Speed	Speed.
amperes			revs. per min.
.24	1.380	2.243	175
.29	1.462	.301	200
.41	1.615	.393	250
.595	1.775	.477	300
.895	1.952	.544	350
1.297	0.113	.602	400
1.72	0.230	.653	450
2.20	0.342	.699	500
2.385	0.378	.714	517

The logarithms will be found plotted in Fig. 3, as usual.

The experiments were repeated, and the results plotted. From this the following numbers have been obtained:

Net Torque. (1 Ampere = .36 Inch-Pounds.)	Log. Net Torque.	Log. Speed.	Speed.
amperes			revs. per min.
.104	1.017	2.000	100
.12	1.079	2.065	116
.137	1.137	2.109	128½
.145	1.161	2.151	141½
.153	1.185	2.158	144
.175	1.243	2.201	159
.20	1.301	2.232	170½
.22	1.343	2.264	183½
.23	1.362	2.274	188
.274	1.438	2.318	208
.33	1.580	2.398	250
.56	1.748	2.477	300
.87	1.940	2.544	350
1.26	0.100	2.602	400
1.71	0.233	2.653	450
2.20	0.342	2.699	500
2.485	0.395	2.720	525

The slope of the curve drawn through the points in Fig. 3, corresponding to columns 2 and 3 above, is 2.59 above the critical speed, which comes out at about 250 revolutions per minute, as before. For the very lowest speeds the slope is 1, as demanded by the usual hypothesis of fluid friction, but between the two there is another portion, curiously straight, whose slope is of intermediate value, and it is worthy of note that the lines through the points immediately below the critical speed for all the other series of experiments have all approximately the same slope—*viz.*, 1.5. This concludes the first and main portion of the preliminary experiments.

CONCLUSIONS.

A glance at Fig. 3, where the results are collected, shows that in every case, at above what I have called the critical speed for each disc, log. torque plotted on a log. speed base gave a straight line, and the slope of all the straight lines was about the same.

2.33, 2.33 } 15-inch disc.
2.82, 2.55 } 22-inch "
2.47, 2.59 } 27-inch "

Mean 2.515

This means, of course, that the torque required varied as about the 2.5th power of the angular velocity; and, therefore, that the power absorbed was proportional to the 3.5th power roughly.

The simplicity of this formula seems to me to make it almost certain that the power measured was almost wholly expended in overcoming the force I wished to measure. Had the other losses been considerable—unless they all followed the same law, which is scarcely conceivable—it would have been impossible for such a simple law to be arrived at.

I have not paid much attention to the points obtained for speeds below the critical, owing to the way errors are multiplied by this method at low angular velocities; but the torque would certainly seem to vary as some power of the speed higher than the first, for speeds not much below the discontinuity.

The critical speeds mentioned above, of course, vary with the size of the discs; they may, perhaps, also vary with its surface and the atmospheric conditions. I have not determined them very exactly for the three discs used in the above experiments, but they seem to be roughly in the inverse ratio of the squares of the diameters:

Diameter of disc in inches: D ..	15	22	27
Critical speed in revolutions per minute (approximate): n	800	350	250
n D²	180,000	170,000	182,000

I hope to repeat these experiments with ebonite discs, which will all have the same kind of surface, and which will be so stiff that they will not exhibit the waves and other vibrations that traveled over the paper ones when the draught became excessive.

The barometer, thermometer and hygrometer readings were not taken when the experiments were made, and the influence of the state of the atmosphere, if any, is a thing I hope to determine in the future. I also intend to determine the influence of form on the amount of torque. That it has a great influence is certain; in some experiments on the bursting speeds of wheels carried out at the Ease School by Professor Benjamin, and described in *Fielden's Magazine* for September, 1902, it was found impossible to speed one form of wheel (something like a bicycle wheel) up to the bursting point till it had been encased in a cover, giving it a smooth outline.

One of the first experiments to be done when I have a rigid disc will be to try it with and without a rim, and see whether it will reduce the effect of friction by hindering the escape at the periphery of the air pumped out from the centre, as probably it is in this pumping effect that the power is lost.

I have left the consideration of the effect of size till last, because it was in this direction that I got what were to me the most astonishing results, and those which most tended to show how important the effects here measured may become.

If T represents the torque required to keep a disc of diameter D rotating at a certain constant speed, it seems natural to suppose that

$$T = k\,D^a$$

where k and a are constants; whence we have

$$\left(\frac{T_1}{T_2}\right)_{\substack{\text{speed}\\\text{constant}}} = \left(\frac{D_1}{D_2}\right)^a,$$

i. e.,

$$\log. T_1 - \log. T_2 = a\,(\log. D_1 - \log. D_2),$$

or,

$$a = \frac{\log. T_1 - \log. T_2}{\log. D_1 - \log. D_2}.$$

Now from Fig. 3 we can get $\bar{1}.400$ and 0.300 as the values for log. T for the fifteen-inch and twenty-two-inch discs respectively at a certain speed (rather more than 800 revolutions per minute) above the critical speed of the smaller. For our very rough calculation we may neglect the small difference in the value of one ampere in pound-inches in the two experiments due to difference of field strength, and this gives us 0.90 for log. T_2 — log. T_1,

while log. $D_2 - D_1$ = log. 21.82 — log. 15.04 = 0.1617, whence we get $a = 5.56$ about.

As a mean of several estimations of log. $\frac{T_3}{T_1}$ at two different speeds, both above the critical speed of the smaller disc, I found 0.619. Now, log. 26.83—log. 21.82 = 0.089. Here we get, therefore, 6.9 as the value for a.

By prolonging the curves in Fig. 3 for the twenty-seven-inch disc upward till they cut the ordinate at log. 1,000, we find 1.1 for their mean height for that speed, at which the height of the two sets of points for the fifteen-inch disc is $\bar{1}.6$. Subtracting, we get 1.5, into which log. $D_3 - \log D_1 = 0.2514$ goes about six times, which is, of course, about the mean of the two previous values for a.

Now this value appeared to me preposterously large. It means that if a certain disc rotating at a certain speed absorbed only six watts—as, for instance, a twenty-seven-inch disc at 550 revolutions per minute—then one only twice that size —*i. e.*, only four feet six inches— would dissipate no less than one-half horse-power, and a nine-foot disc thirty-two horse-power!

I was advised at this point by Mr. Castle to test this by a disc very much larger than any I had yet tried, so I made one 47.1 inches across, out of canvas-backed diagram paper, which I damped and ironed to flatten it. It alone weighed eleven ounces, and with the boss for attaching it to the shaft, fourteen ounces. It would manifestly have overpowered the small motor I had hitherto used, so I employed a one-half horse-power motor, which was run off the 200-volt mains. Its field, unfortunately, was not saturated, and as the pressure in the mains varies about two or three volts throughout the day, the induction was apt to change.

When running light at speeds below 800 or 900 revolutions per minute, it took below 0.30 ampere; and as my ammeter did not read below that point, I had to arrive at the torque necessary to keep the motor running light at those speeds by the unsatisfactory process of extrapolation.

From the volt-speed curve we get 6.6 revolutions per minute per volt, which means that one ampere through the armature gave 12.8 pound-inches of torque, which is 35.6 times that given by the small motor when revolving 235 times per minute per volt.

The current-speed curve, after producing the blank experiment line backward, gave the following numbers:

Net Torque (1 Ampere = 12.8 Lb.-Inches.	Log. Torque.	Log. Speed.	Speed.
amperes			r.p.m.
.255	1.406	2.398	250
.355	1.550	.477	300
.645	1.810	.602	400
1.020	0.009	.699	500
1.260	0.100	.740	550

To make the relation of the curve obtained by plotting columns 2 and 3 to the other curves in Fig. 3 more clear, however, before plotting 1.551 (= log. 35.6) has been added to each value of log. torque given above, thus giving

Log. speed.....	2.398	2.477	2.602	2.699	2.740
Log. torque....	0.958	1.101	1.361	1.560	1.652

The slope of the line drawn through these points is only 2.06. From a number of odd experiments made before the above series was performed, it seemed probable that the torques given above for the lower speeds were too high. A second series was therefore performed, in the curve of which the line through the net volts obtained from the readings of the Weston voltmeter gave 1 volt = 6.67 revolutions per minute, whence 1 ampere = 12.7 pound-inches of torque. By subtracting the ordinates, as usual, we get

Torque (1 Ampere = 12.7 In. Lb.).	Log. Torque.	Log. (35.3 Torque).	Log. Speed.	Speed.
amperes.				r.p.m.
.205	$\bar{1}.312$	.860	2.398	250
.310	$\bar{1}.491$	1.039	.477	300
.59	$\bar{1}.771$	1.319	.602	400
.93	$\bar{1}.969$	1.517	.699	500
1.34	0.127	1.675	.778	600
1.83	0.263	1.811	.845	700
2.055	0.313	1.865	.869	740

In column 3 I have added 1.548 $\left(= \log. \frac{12.7}{.36}\right)$ to the numbers in column 2 in order that when plotted with the numbers in column 4 as abscissæ in Fig. 3, they should fall in their proper place. For the first time in any of these experiments I seem to get a slightly curved line; but I have drawn through the points a straight line whose slope is 2.1 about.

I am not able to say why, for this disc, the slope should be so much less than in previous cases, and will proceed at once to consider the point, to clear up which these experiments were made.

The height of the curves in Fig. 3 for the forty-seven-inch disc above those for the twenty-seven-inch disc varies from 1.1 to 1.3 about. Dividing by 0.2444 (= log. 47.1 — log. 26.83) we get from 4.8 to 5.3 for a.

The difference between the ordinates of the forty-seven-inch and twenty-two-inch discs is from 1.68 to 1.86, which, divided by 0.334, the difference of the logarithms of their diameters, gives from 5 to 5.6.

Taking these results with those previously obtained, I think we may safely infer that the torque varies as some power of the diameter higher than the fifth, but considerably below the sixth. Even this result astonished me, till Mr. H. C. Booth pointed out to me that the average linear velocity, as well as the area, increases with the size, and that the arm of the couple also increases, so that, supposing that the force of friction is jointly proportional to the area, and a power of the linear velocity rather greater than the second—a couple of hypotheses not very improbable—we should have the force on an elementary ring of radius r and breadth $d\,r$ when rotating at ω radians per second proportional to $(\omega\,r)^2 + {}^a\,r\,d\,r$, where a is a proper fraction, probably less than 0.5. This would produce a torque proportional to $(\omega\,r)^2 + {}^a\,r\,d\,r \times r$, say

$$= C\,(\omega\,r)^2 + {}^a\,r\,d\,r \times r.$$
$$= C\,\omega^2 + {}^a\,r^1 + {}^a\,d\,r.$$

Integrating this with respect to r from the centre to the rim we get

$$T = C\,\omega^2 + {}^a\,r^5 + {}^a$$

which would roughly explain the numbers obtained. It is not a complete theory of the results, of course, and it takes into account none of the changes which occurs when we pass below the critical speed. I hope in future to be able to determine C and a accurately and to get out a formula which shall include the parts of the disc below the critical speed.

The following method of getting very nearly the same result as that given above was sketched out for me by Professor Perry on the assumption that all the loss of energy is due in the end to the pumping action of the disc on the surrounding air.

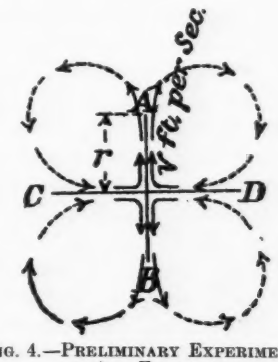


FIG. 4.—PRELIMINARY EXPERIMENTS IN AIR FRICTION.

Let AB, Fig. 4, be the edge view of a disc of radius r rotating on a shaft CD in an infinite room with angular velocity ω. Then it will act as a pump receiving air at its centre parallel to CD, and delivering it radially at A and B to travel along the path indicated by the arrows,

and to return ultimately to the centre again. The length l of any such path must be proportional to the linear dimensions of the disc—*i. e.*, to r, and so will d, the mean hydraulic depth of the path it takes; so, using the usual formula for the loss of energy in one pound of a fluid flowing through a pipe of length l and diameter d, loss of K.E. $= k \frac{l}{d} \frac{v^2}{2g}$ we see that for a disc of any size the loss of energy of each pound of air set in motion by it will be proportional to the square of that air's velocity, and independent of the size of the disc.

Now, the law for a centrifugal pump or fan is that the difference of pressure it causes close to its surface varies as $\omega^2 r^2$, and therefore that the work done on the air is proportional to $\omega^2 r^2$, and this must be equal to what the air loses subsequently—*i. e.*,

$$w^2 r^2 \propto v^2$$

or

$$w r \propto v$$

(This is also one of the rules arrived at from fan practice.)

Now, the quantity of air set in motion per second is proportional to the area of the disc and to the velocity with which it leaves it, or

$$W \propto v r^2.$$

But the energy dissipated per pound of air has been shown to vary as v^2.

Therefore the energy dissipated per second will be—

$$\propto W v^2 = K v r^2 \times v^2 = K v^3 r^2.$$

But $v \propto w r$.

Therefore the rate of the loss of energy is $= C \omega^3 r^5$, which agrees pretty well with the experimental results.

The National Bureau of Standards.

To the Editor of the Electrical Review:

My work as an instrument manufacturer having placed me in close touch with the work being done by the National Bureau of Standards, and having observed the influence of the bureau's work on electrical industries in general, I wish to invite your attention to the high esteem in which the instrument manufacturer regards the work being done by the bureau. Lord Kelvin has remarked that "Before we can thoroughly understand anything we must be able to measure it." We may add, that we must also be able to accurately measure anything before it can be sold with justice to either buyer or seller. The calibration of power meters involves an accurate determination of standards which will enable all the practical electrical quantities to be compared with their units. These units, the volt, ampere, ohm, microfarad, henry, etc., are easily defined, but the standards expressing them must, for their final determination, be referred to the standards of definition. The comparison of electrical secondary standards with the fundamental standards of definition is a laborious process, requiring a special and costly equipment and much scientific skill. When supplying to manufacturers the standards and apparatus with which they measure the quantities that they sell, the instrument maker must have reliable standards. He can not undertake the comparison of his own standards with the standards of definition. Heretofore, practically all the fundamental standards of resistance, voltage, capacity, self-induction, etc., which the electrical instrument maker constantly uses, have been purchased from abroad, and the makers selling apparatus to manufacturers have been compelled to use foreign standards in the calibration and adjusting of their own apparatus. Consumers, manufacturers and instrument makers are all directly dependent upon some responsible source from which standards, having certified, reliable values, can be obtained. It seems almost disgraceful that in a country having our vast industries that only until recently have we been able to go elsewhere than to Europe, and chiefly to the German Reichsanstalt, for all our final electrical standards. Happily, the situation is now entirely changed. The founding of the National Bureau of Standards has, and is rapidly, placing the American manufacturer of apparatus and the companies selling electrical power in a position where they can obtain at home all the most accurate standards of reference. We wish to urge that your journal will extend information regarding the value and excellence of the work which the bureau is doing, and advocate editorially that makers and users of all kinds of electrical apparatus and electrical standards will avail themselves of the opportunity now presented of having all quantities measured or sold definitely known.

The work of the bureau is in no wise confined to the verification and standardizing of electrical standards and quantities, but it is this side of their work that the writer is familiar with and which he wishes to urge upon your journal to emphasize. Edwin F. Northrup.

Philadelphia, January 15.

Breakdown at the Generating Station, Bristol, England.

A total breakdown occurred at the Bristol, England, generating station on the evening of December 23, due to a fire which broke out on the high-tension switchboard at the Temple Back powerhouse. In an official report of the accident, Mr. H. F. Proctor, city electrical engineer, states that the fire, which occurred at 5.15 P. M., at the busiest time of the day and during one of the busiest days of the year, totally destroyed the 2,000-volt high-tension Ferranti switch gear and damaged the roof and windows of the engine room. The exact spot at which the trouble commenced and the cause of the accident were not known at the time the report was made. The machine switchboard, wattmeter switchboard, trunk feeders from the Avonbank Electricity Works, which works in parallel with the Temple Back station, and the whole of the forty-four feeder panels, were totally destroyed, as well as all the cables leading up to them from underground. Energetic steps were taken to get the station going again, and by 2 A. M. on Thursday morning the whole of the continuous-current power consumers were being supplied. This was in time to enable the newspapers, all of which use electric power for printing, to get out their early editions.

Trunk cables from the Avonbank Electricity Works were joined across to the Clifton and Redland feeders outside the works, thus enabling the alternating-current supply to those districts to be started up at about the same hour. Three hundred and sixty-five street arc lamps were put in operation at the same time, and many other arc lighting circuits were started up shortly afterward. The line resistance and other controlling gear were very wet and caused some trouble, but the bulk of the lighting was kept going. A temporary distributing switchboard was at once put in, to which were joined feeders from the Avonbank station. The whole of the supply, both alternating and continuous, was in full working order by 8 P. M. Thursday.

Mr. H. D. Clothier, manager for the Ferranti Company's switch gear department, investigated the accident. The switchboard was one of the Ferranti cellular type, ordered nearly five years ago. At the time of the accident the output of the station was about 3,000 kilowatts, which was being taken up by two 400-kilowatt machines at the Temple Back, and four 750-kilowatt machines at the Avonbank station. For some reason one or both of the machine fuses at Temple Back blew. This action was apparently followed by a severe arc in the fuse panel, which burned through the slate above it, melting the fuse contacts and the metallic connections between the fuses and the switches. The arc thus formed seems to have been confined to the machine panels, but it ignited the linoleum floor covering and the insulation over the inner conductor of the cables connecting the terminals under the bottom switch-plate. The flames from this material spread quickly over the entire switch gear and to the roof of the building. A close examination on Thursday revealed the fact that the damage to the power station and the machinery was not very extensive, as the fire was confined to the woodwork used in the structure. Mr. Clothier says that the fuse used here was of an obsolete type, yet the arc caused by its failure was confined to the switch and fuse panels of three or four machines.

FOURTH ANNUAL AUTOMOBILE SHOW AT MADISON SQUARE GARDEN.

AN ELABORATE SHOWING OF HORSELESS VEHICLES.

The fourth annual automobile show at Madison Square Garden opened for visitors Saturday evening, January 16, to continue there until January 23.

When the doors of Madison Square Garden opened the people began to troop into the big arena and in a very few minutes the aisles were filled and the masters of the industry were chatting with the patrons of it on familiar terms, yet earnestly.

All the available space was taken. In the basement, in the restaurant and throughout two encircling balconies were assembled the motor vehicles of every size and style, power and price, together with tires, lamps, bells and an endless assortment of accessories and sundries, and among them the people wandered, looking, enquiring, examining, and pausing to study and consider.

The big arena was profusely decorated, and the electric lights blazed from roof girders, balcony sides and the signs of the exhibitors; the band played alluring airs, and the ensemble was quite dazzling and delightful.

The Electric Storage Battery Company, Philadelphia, Pa., showed its new storage batteries of cells of the four-cell express type. This cell has been especially designed to meet the requirements of business vehicles, such as trucks and delivery wagons. The jars are made very strong to resist the hard usage of such service.

The Baker Motor Vehicle Company, Cleveland, Ohio, exhibited a new electric vehicle especially designed for the new "Edison" storage battery. The company's exhibit was in charge of Mr. M. L. Goss and Mr. J. E. Demar.

The Buffalo Electric Carriage Company, Buffalo, N. Y., exhibited its line of motor vehicles. The company's exhibit was in charge of Mr. Frank Babcock.

The Electrical Vehicle Company, Hartford, Ct., had many different types of vehicles exhibited. The exhibit was in charge of Mr. F. C. Armstrong.

The Varley Duplex Magnet Company, Providence, R. I., showed a line of its goods, in charge of Mr. Richard Varley.

The Electric Contract Company, New York city, N. Y., showed a full line of goods which it handles. The exhibit was in charge of Mr. J. C. Chase.

The R. E. Dietz Company, New York city, N. Y., displayed its line of oil and acetylene lamps. The display was in charge of Mr. Goetze.

The Dayton Electric Manufacturing Company, Dayton, Ohio, showed a line of its manufacture, in charge of Mr. Apple.

The General Electric Company had an interesting exhibit, in charge of Mr. Muzzy.

The Rainier Company, New York city, exhibited a line of motor vehicles for trucking and for pleasure, in charge of Mr. C. G. Rainier.

The Dow Portable Electric Company, Braintree, Mass., exhibited a line of its manufacture, in charge of Mr. A. M. Dow.

The Pope Motor Car Company showed many styles of electric vehicles. Its vehicles are so constructed that either the Sperry, Edison or Exide batteries can be placed in them. The exhibit was in charge of Mr. Robert L. Winkley.

The American Coil Company, West Somerville, Mass., exhibited a line of its manufacture, in charge of Mr. H. C. Folger.

Charles E. Miller, New York city, N. Y., distributed a little souvenir in the shape of an automobile horn.

The B. F. Goodrich Rubber Company, Akron, Ohio, exhibited a line of its manufacture, in charge of Mr. H. T. Sheldon.

The National Carbon Company, Cleveland, Ohio, had a very interesting exhibit.

The Gould Manufacturing Company, Trenton, N. J., exhibited a line of its goods which is attracting considerable attention.

The Fischer Motor Vehicle Company, Hoboken, N. J., had a very interesting exhibit.

Among the many other exhibitors were F. A. La Roche & Company, Shelby Steel Tube Company, the G. N. Pierce Company, Federal Manufacturing Company, Detroit Motor Works, Winton Motor Carriage Company, White Sewing Machine Company, Emil Grossman, etc. Many of the automobile manufacturing companies which were unable to obtain space at Madison Square Garden and many companies which had obtained space are exhibiting their apparatus and supplies at the Herald Square Exhibition Hall, Broadway and Thirty-fourth street, New York city. The Herald Square automobile show opened Saturday, January 16, and will continue one week after the show at the garden.

Incandescent Lamps for Edinburgh.

A report from U. S. Consul Warner, at Leipsic, Germany, states that a firm located at Cologne has just received an order from the city of Edinburgh, Scotland, for 10,000 incandescent lamps. Fifty-four firms are reported to have submitted bids upon this order.

The Twelfth Annual Convention of the Northwestern Electrical Association.

The twelfth annual convention of the Northwestern Electrical Association was held in Milwaukee, Wis., Wednesday, Thursday and Friday, January 20, 21 and 22. The headquarters of the convention was the Hotel Pfister.

The following programme was announced:

Wednesday Morning—Roll call. Reading of minutes. President's address. Secretary and treasurer's report.

Wednesday Afternoon — Appointment of nominating and membership committees. Applications for memberships. Reports of all committees except nominating. Miscellaneous business. "Storage Batteries for Central Station Work," J. M. S. Waring; "Peculiarities of Magnets," Richard Varley; "Rectifiers," W. Scheidel.

Wednesday evening a theatre party was given.

Thursday Morning —"Double-Current Generators in Their Connection with Double-Current Supply," W. L. Waters; "Central Station Heating," W. H. Schott; "Standard Practice in the Use of Alternating-Current Electrical Apparatus," J. J. Gibson.

Thursday Afternoon—Report of nominating committee and election of officers.

"Steam Turbines," James Lyman; "Rectifiers," Professor C. F. Burgess; "Radium," Professor R. A. Milliken.

Thursday Evening—Annual banquet.

Friday Morning—Unfinished business and adjournment.

New York Electrical Society.

Professor W. E. Goldsborough will lecture before the New York Electrical Society on Wednesday evening, January 27, at 19 West Forty-fourth street, on "The Influence of Electricity upon Expositions." Professor Goldsborough will elaborate on the expansion of installations of electric power for expositions, starting with the earliest and most primitive types of exhibit. The great changes in the plans of exhibit installations will be brought out leading up to an estimate of the installation which will be made in the Palace of Electricity at the St. Louis Exposition. A general view will be given in connection with the electrical decorative and illuminating effects to be used at the exposition. The lecture will be fully illustrated by lantern slides, and a special invitation will be extended to ladies to attend.

ELECTRICAL MINING NOTES.

BY SIDNEY F. WALKER.

CABLES ABOUT GOLD AND TIN MINES.

One of the difficulties in connection with the distribution of power for drilling or anything else about gold or tin mines, is the probability of the cables being damaged. There is the same trouble in coal mines in England, and it is likely to be greater in gold and tin mines, because of the greater irregularity of the workings, the greater number of sharp corners the cables will have to be bent round, and much greater quantity of water present. Armoring cables makes them unwieldy and liable to have the armor pushed through the insulation when the cable is bent. In my opinion, the cables that will answer best for gold and tin mines are those in which no metal is employed outside of the insulating material, and in which the insulating material is thick and well protected by substances which will keep the water from the rubber or whatever may be employed for insulation. I will refer to this more in connection with signaling.

ELECTRIC SIGNALS FOR GOLD AND TIN MINES.

One of the mine managers on the Rand recently deplored the absence of any good system of signaling. Electric signals are undoubtedly the thing for the purpose, but there are considerable difficulties in working them satisfactorily. On the other hand, it may be confidently stated that mine managers could have efficient signals worked electrically if they could pay the necessary price for them. Water is the great enemy in this case, and the peculiar arrangement of the workings, the shafts, etc., where the conductors for the signals would have to be placed. It is not only that the water would get through the insulation, and eat away the conductor, but it would also get at the connections of the ringing keys and eat them away. In addition, leakage paths would be formed at every ringing key which would seriously strain the battery. The way out of the difficulty is, first, as to the ringing keys. Make these very large, very simple, very strong. Some simple form of lever kept out of contact by gravity, if possible, or by a strong spring, the lever being very strong, and connected to the terminals by strong metal straps, the terminals again being large, and the whole being so arranged that it can easily be inspected by the electrician, would probably answer well.

Next as to the conductors. Again make them as thick as you can, consistent with handling them, making connections, etc. Do not use less than No. 14 gauge, and larger if you can. Do not use stranded wires. The object of using a large gauge is to allow time for the signal to work while the water is acting upon the conductor, and for the man in charge to come and scrape off the oxide of copper before it reaches the circuit. With the quantity of water that is present in gold mines, the copper conductors will always be attacked, wherever they are exposed, and for that reason it is better to have all connections to terminals in sight, so that the attendant can see what is going on. The water will always penetrate to the connections of the key, if they are concealed. Another secret in connection with signals is, do not have battery wires in the shaft. A battery at every place where a ringing key is to be fixed gives a little more trouble in looking after the batteries, and lightens the troubles in connection with wires eaten away, especially in wet shafts. Do not connect the signals to the electric light or power service, you will have no end of trouble if you do. Use any good form of battery or accumulator, and test it periodically. For the insulation of the conductors, the same remarks apply as to cables for lighting or power; put on plenty of whatever form of insulator you use, and protect it with as much as you can in the way of waterproof material, such as yarn steeped in waterproof substances. The longer that the water can be kept from reaching the outside of the insulating substance, the longer life will the cable or conductor have. Also the thicker the insulating substance, the longer will be the time required for oxidation to take place all through it, and therefore also the longer the life of the cable or conductor.

It may be of interest to note that gold mines are being worked now in pretty well every part of the world. In addition to the older mines of the western states, and of New South Wales and Victoria, Australia, mines are at work in Western Australia, in Tasmania, the important native state of Mysore, in India; Egypt, in the upper reaches of the Nile, Queensland, and numerous other places. In Egypt and Rhodesia many of the old workings have been struck, but the ancients do not appear to have gone into the business in the thorough manner in which modern nations do. The rule seems to have been that what could be done by slaves was done, when slaves were obtainable, slave life being a negligible quantity, and there the matter ended. The difficulties of getting gold from the ore in those days must have been very great, seeing that in existing mines a ton of stone has sometimes to be dealt with to produce a few pennyweights of gold. A mine whose stone produces an ounce to the ton is a wealthy one.

Two New Forms of Electrolytic Cell for Production of Bleaching Solutions.

Two new forms of electrolytic cell designed for producing bleaching solutions are here described by Mr. J. B. C. Kershaw. The first is a German design, owned by the Fabrik Elektrische Bleich Apparate. It consists of a series of cells, seven in number, arranged in a step system. Each separate unit consists of a horizontal plate formed of hard black ebonite-like material,. provided with longitudinal, narrow channels, in which strips of a platinum-iridium alloy of peculiar form are fixed, and constitute the electrodes. The main conductors run alongside the series of plates, the electrical contact is made by bent strips of the same alloy. Each of the plates is provided with twenty-two longitudinal channels, and the electrodes are so designed and arranged that the total area of the anode surfaces is five to ten times greater than that of the cathodic area. A nine per cent solution of common salt, contained in a storage vat at the upper end of the series of plates, is allowed to flow over the apparatus, finding its way in a number of streamlets, and finally reaching a storage vat placed at the lower end, whence it is returned to the upper vat, the flow being repeated until the percentage of free chlorine has risen to the limit desired. Each plate absorbs seven amperes at 100 volts—about one electrical horse-power—and the seven plates produce one kilogramme of free chlorine per hour. A suitable arrangement of electrodes makes it possible to use 220 volts. The maximum limit of free chlorine obtainable in the electrolyte is stated to be thirty grammes per litre. The novel features of this cell are the division of the electrolyte into streamlets, and the use of electrodes with the anode's surface many times greater than that of the corresponding cathodes. The second apparatus is the invention of G. K. Atkins, of London. It consists of a cylindrical wooden trough lined with lead, the lead being covered with carbon blocks, which forms the anodes of the cell. A wooden cylinder, also covered with lead, revolves on bearings placed at the ends of the trough, and forms the cathode, current being conducted to it through the collecting ring and brushes. The trough is filled with a ten per cent solution of sodium chloride, and electrolysis proceeds in the one-half-inch space separating anode and cathode. The revolution of the cathode is designed to lessen polarization, and it is said to be effective. A comparison is made of the yield of the German apparatus with other well-known types, and if the figures given above are correct, the new cell is the most efficient of any that has yet been brought out.—*Abstracted from the Electrical Review (London), December 25.*

IRRIGATION BY MEANS OF ELECTRICALLY DRIVEN PUMPS.

THE SAGE BRUSH DESERT TRANSFORMED INTO FERTILE ORANGE GROVES.

One of the interesting sights which one may see if he visits the country about Los Angeles, Cal., is the transformation of vast plains of sage brush desert into gorgeous and profitable groves of orange trees, through the medium of electricity.

Stretching for miles away from Los Angeles both east and west is an area of something like 2,500 square miles of land on which nothing grows under natural conditions except sage brush, jack rabbits, grease wood and a little wild mustard. From May to November not a drop of rain is to be expected, and the only crop that the ablest farmer could raise on most of this area was an occasional harvest of barley. Sowing this grain in the fall just before the rains began it would get a start and mature sometimes before the summer drought began and shriveled it up.

Even during the wet season the rainfall is small, only about twenty-five inches for the year.

Mountains skirt the district and from these low streams which are small in volume but contain much energy because of the heights down which they tumble in the rocky cañons.

The hint of how to make the sage plain bloom came from a few clever farmers who impounded some of the little streams and turned the water upon their lands.

Wherever the water went there followed verdure. The climate made the lands ideal under irrigation for raising oranges. The streams, however, were inadequate to supply water to irrigate more than a mere fringe of the sage-clad lands.

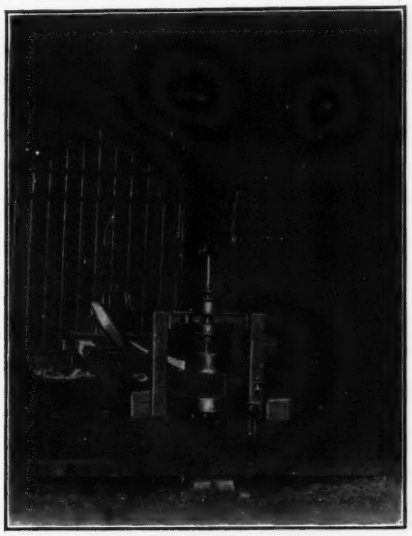
Of who discerned that underneath the sage plains there was an abundance of water that could be tapped by wells there is no record.

When this knowledge became generally dissemenated immigrants flocked into the country and wells were sunk in great numbers. They found water in ample quantity at depths ranging from 50 to 1,000 feet below the surface.

Then came the question of how to raise it. Windmills could not answer the purpose. They were too unreliable. When a farmer wants water in that country, he wants it as a Texan needs a pistol. He has got to have it right away and a lot of it.

Some farmers put in gasoline engines. These were better than nothing, but the real solution came when two power companies went up into the Sierra Madre mountains, eighty-three miles east of Los Angeles, and harnessed up the high falling streams to turbines and electric generators.

It is doubtful if the projectors of



INSIDE OF THE SHED. THE SIMPLE PUMPING EQUIPMENT.

these enterprises realized what a transformation in the sage lands they would procure when they undertook their work.

Los Angeles itself was the market they were seeking for their power. Soon the plains from Los Angeles to the Sierra Madre was strung with two lines of poles and wires and the manner in which the engineers annihilated the effects of distance by using electric currents of 15,000 to 33,000 volts for transmission created wonder even in the electrical world.

To-day these mountain waterfalls are doing work in shops and factories in Los Angeles, and lighting houses and streets, but the most wonderful transformation which they have effected is on the sage plains.

It did not take the westerners long to discover that a little electrical current tapped from one of the trunk lines would do their pumping for them more cheaply and with more certainty than anything else.

To-day branch lines run out in all directions from the trunk lines and hundreds of orange farmers are their customers.

The land is taken up mostly in modest sized ranches of from 50 to 1,000 acres. Lucky Baldwin has one big ranch in the sage country of 30,000 acres.

But whether the farmer be a big or a little one, his operations are along like lines. A well is driven for each area of from fifty to seventy-five acres. Over the well is built a little house and within this is installed a pump and an electric motor. Somewhere in the neighborhood the high-tension electric line is tapped and wires are taken to the pumping station. Outside the station the wires go to a transformer which reduces the voltage so that it can be used in the motor.

Troughs or ditches lead from the pumping station to the series of irrigation

A TYPICAL PUMP HOUSE. CURRENT SUPPLIED FROM POLE LINE.

ditches, with flashboards to direct the water to where it is needed.

All the farmer has to do is to fix his flashboards, turn an electric switch and go about his other business. Within the little station the electric motor buzzes

away, drawing a copious stream of water from the bowels of the earth and this it will continue to do day and night, week days and Sundays, as long as it is needed. When no more water is needed the farmer turns the switch again and his expense for current ceases. The plant for the pumping station is of the simplest. It is the custom to use small centrifugal pumps and to drive these with a small Westinghouse induction motor. Sometimes the motor is mounted upon the top of the pump shaft, and sometimes it is set a few feet away and connected to the pump by a belt.

Many of these small plants supply as much as 100 to 150 miner's inches of water each. While running, a station uses from thirty to seventy-five horsepower.

Although irrigation was only begun in this part of the country about three years ago, there are already between 500 and 600 electric pumping plants installed here.

The lands which were valueless before are now worth from $300 to $500 an acre. After the orange trees come into bearing, they often yield as much as the lands are worth in a single season. The demand for electric current has become so great that one of the supply companies has gone into the mountains 125 miles to the north of Los Angeles and harnessed up the Kern river. Power from that plant will open up new fields for irrigation as well as supply means for pumping oil, which has been discerned in that section.

Philadelphia Branch, American Institute of Electrical Engineers.

The regular meeting of the Philadelphia branch of the American Institute of Electrical Engineers was held Monday, January 11, at the Engineers' Club, of Philadelphia.

Mr. W. C. L. Eglin discussed the paper that Mr. George H. Lukes had presented at the New York meeting, on "Overhead High-Tension Distributing Systems in Suburban Districts." He also presented his own paper on "Safeguards and Regulations in Operation of Overhead Distributing System," with considerable amplification.

Mr. J. T. Hutchings, of the Philadelphia Electric Company, presented a paper, using Mr. E. J. Bechtel's paper on "Automatic Apparatus for Regulating Generator and Feeder Potentials," as a basis, and going somewhat further into the matter than Mr. Bechtel did.

Mr. J. B. Klumpp, of the United Gas Improvement Company, of Philadelphia, presented a paper, discussing and criticising the paper on "Gas Power for Central Stations" read by Mr. J. R. Bibbins at New York.

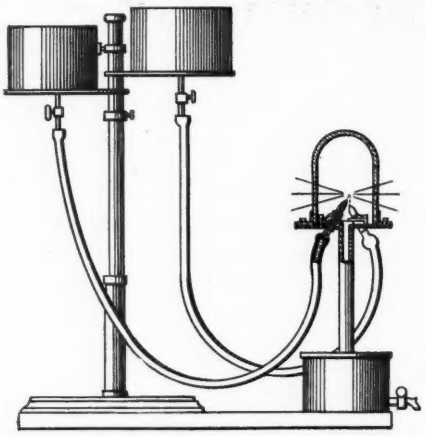
The discussion of these papers was participated in by Messrs. Paul Spencer, W. C. L. Eglin, C. W. Pike, Charles Hewitt, H. A. Foster, J. B. Klumpp and Carl Hering.

ELECTRICAL PATENTS IN 1903.

BY E. G. SIGGERS.

The year 1903, so far as patents in the electrical art are concerned, has developed nothing generic or startling. There have been considerably over thirty thousand mechanical patents, all told, granted, the greatest number yet for one year, and the field of electricity has furnished its full quota of good, bad and indifferent, from the simple, though ingenious, toy to the intricate system built entirely on the theories of scientists.

Every one with any idea of the world of mechanics will realize how thoroughly the subject of electricity permeates it, and consequently the impossibility of unraveling the entire subject in order to present a brief résumé of what has been done in the electrical art, *per se*. However, as straws show which way the wind blows, so an example of a short period



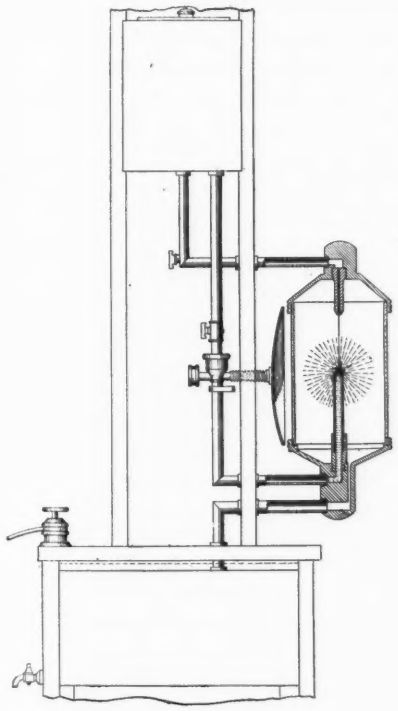
PROFESSOR J. T. WAY'S MERCURY VAPOR LAMP.

will indicate to a considerable extent the trend of the electrical patents for the year just closed.

In the month of December 263 patents which showed on their faces the employment of electricity, in one form or another, were issued. As usual, the General Electric Company stands at the head of concerns which have obtained control of some of these patents. This company has a record of thirty-three for the month, though it will be understood that such record may, and probably is, greatly increased by others purchased after the dates of the patents and not showing the transfer on their faces. Of these thirty-three patents, however, we find that many of the inventors are well known in the world of electricity, including such names as Steinmetz, Hewlett, Potter, Waddell, Geisenhoner, Reist and Churchward, some of whose names appear with great regularity in the patent gazette and in connection with the name of the General Electric Company. The record shows twelve patents to the credit of the Westinghouse Electric and Manufacturing Company for the month of December, and of these six cover the inventions of Mr. Malcolm H. Baker, of Pittsburg, Pa. The Stromberg-Carlson Telephone Company, of Rochester, N. Y., has six patents, while four are credited to the Kellogg Switchboard and Supply Company, all of the latter protecting the inventions of Mr. William W. Dean. Among others of the well-known companies that are found in the index may be mentioned the Gray National Telautograph Company, the Holtzer-Cabot Electrical Company, Interstate Electrical and Manufacturing Company, Swan Manufacturing Company, Gould Storage Battery Company, Consolidated Car Heating Company, Pyle Electric Headlight Company, United States Light and Heating Company, Electrical Storage Battery Company, International Electric Controller Company, United States Electric Clock Company, O'Brien Electric Light Letter Company, Otis Elevator Company, Western Electric Company, and Sangamo Electric Company. These names appear in the record for one month and suggest the various lines along which patents are being taken out.

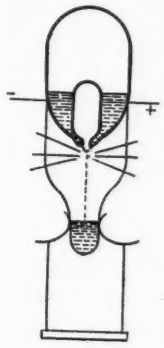
As for the branches in which particular activity is being shown, it may be said that the whole art is active, and inventors are, with their usual unrest, striving for perfection in their individual lines. Many branches are dropping off in the number of applications made and consequently in the patents issued, the cause undoubtedly being that in certain classes levels are being reached which it seems impossible to pass until some apparently insurmountable obstacle is overcome. This is perhaps true in such lines as the X-ray machine and Nernst lamps, which, though they will always be important, have been brought to light, rapidly developed, and, like fads, gradually die out of the public mind or become so common that nothing is thought of them, their only existence being known by an occasional patent and improvement. At present, however, considerable attention is being paid to improvements in turbines and rotary engines for use in the generation of electricity. The future possibilities in this branch are indicated by the fact that this attention is not entirely confined to independent inventors, but is also shown among the larger electrical companies, which are purchasing patents thereon. Another feature that is attracting very great attention is the Cooper Hewitt

mercury vapor lamp, which has become such an alluring advertising medium in the stores of most of the larger cities. The original conception of this lamp, like so many others, is not at all modern, but appears to have been first evolved by an English civil engineer, Mr. Harrison, residing in London, who obtained an English patent in 1858. His idea was to project a fine stream of falling mercury against a lower body of the same material and to pass a current of electricity therethrough. At the impingement point the light was formed or produced. This was followed by Professor John T. Way, also an Englishman, who in 1861 obtained two patents in the United States on his first forms of lamps. He projected two separate streams of mercury against each other and connected these streams, respectively, with the two poles of a suitable source of electrical energy. The mercury was not enclosed, but was obtained from two small reservoirs, and after use dropped into a receiving vessel from which it could be returned to the reservoirs.

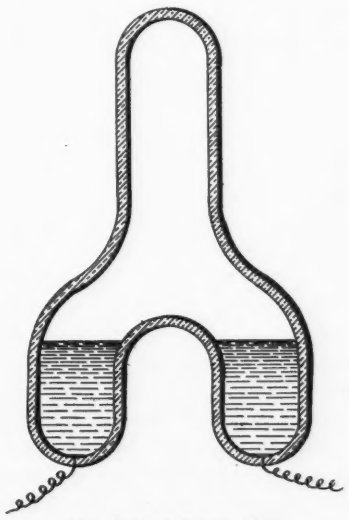


HARRISON MERCURY LAMP, 1858.

Records of the experimental application of the Way invention to vessels in certain harbors of England in 1861 describe the blinding light obtained by this arrangement. The lamp, however, seems to have lapsed more or less into obscurity up to the present time, though it appears to have been resuscitated by John Rapieff, another Englishman, in 1879, who still used the two streams flowing from separate reservoirs, but arranged in the same vessel. A very important step, however, was made by Dr. L. Aron, a German, who in 1895 first proposed enclosing the bodies of mercury and placing them in an inverted Y-shaped tube, the upper portion of which constituted a condensing chamber. The improvement, however, amounted to little more than a laboratory experiment, and it required American genius to bring the idea to a practical commercial basis. This genius has been found mostly in Mr. Hewitt, though there are several American inventors who have played important parts in its development. Mr. Hewitt obtained his first patents September 17, 1901, and has practically given to the world the latest electric light. As a description of his lamp can be found in the September 5, 1903, issue of the ELECTRICAL REVIEW, it is not necessary to enter upon the same here.



JOHN RAPIEFF'S MERCURY LAMP, 1879.



DR. ARON'S LAMP, 1895.

Material activity in the electrical art is also noticeable among the foreigners, more particularly the Germans and English, and to a less extent among the French. These inventors realize more and more the importance of protecting their ideas in this country, and consequently we find that in the month of December 377 patents were obtained by them here. These, of course, do not all relate to the electrical art, but said art has its proportion. Nor do we find the patents limited to the more advanced countries of Europe. Indeed, to show how the art is finding its way and followers throughout the world, we discover in the record for this month of December, 1903, a United States patent granted on an electric battery to Mr. Sakizo Yai, of Tokio, Japan, and who, from his name, is apparently a native of that progressive country.

Meeting of Electrical Contractors.

The annual meeting of the United Electrical Contractors' Association of New York State was held on January 19, 1904, at the Building Trades Club. The following officers were elected to serve for one year: President, Marshall L. Barnes, Troy; vice-president, James R. Strong, New York; secretary, Frederick Fish, Rochester, and treasurer, J. C. Stearns, Buffalo.

In the evening an enjoyable banquet was given by the Electrical Contractors' Association of New York city, at Delmonico's, Forty-fourth street and Fifth avenue.

Mr. J. C. Hatzell made the welcoming address. He congratulated the delegates on the result of their labors during the day, in consolidating so many opinions, and in being representative of so great an industry, among other things saying: "A comparative infant, as industries go, of scarcely twenty-five years' growth, it has grown to enormous proportions, and at its present rate of progress, who can foretell its future? This great progress in a large measure is due to the character and class of men who have been connected with it since its inception, and who are still connected with it, and those who have entered the field since. Our electrical fraternities are in the foremost ranks of science, finance and industry. You can justly consider yourselves among the great captains of industry, for you move or help to move the wheels of commerce; and it requires no great stretch of the imagination to predict that electricity will eventually be the sole motive power for these wheels."

After the banquet those present were entertained with a number of selections by prominent vaudeville artists.

Reviews of Current Engineering and Scientific Literature.

Development of Electric Power in Switzerland.

Switzerland, not possessing any coal mines, has been able to counterbalance partially that unfortunate condition by developing its many waterfalls. The following figures relate to the year 1902, and are only approximately correct at the present time, as development has been constantly going on. In twenty-two cantons reported upon, the power development varies from 61 to 22,650 electrical horse-power. In two cantons, Argovie and Berne, the development amounts to over 20,000 horse-power, being 22,650 and 20,500, respectively. In each one of three other cantons there is over 11,000 horse-power developed, and in five it is over 5,000 each. The total development is about 140,000 electrical horse-power—a very creditable figure.—*Translated and abstracted from the Revue Pratique de l'Electricité* (*Paris*), *December* 20.

The Physical Decomposition of the Earth's Permanent Magnetic Field.

This is the third article upon the subject by Mr. L. A. Bauer. It is divided into three parts. The first considers the earth's total magnetic energy; the second, the seat of the principal cause of the secular variation, and the third, a note on the importance of the Gauss theory. Under the first heading the author examines all records of magnetic surveys, with a view to determining whether there has been any change in the earth's total magnetic energy. Two ways are given for calculating the total magnetic energy, both of which are carried through and are quite mathematical. The results indicate that from 1838 to 1884—forty-six years—there has been a loss in the total earth's magnetism of 3.15 per cent. The author, commenting upon this, states that the result is so startling, if it be true, that if the loss were to continue at the same rate, the earth would lose its entire magnetic energy in 1,600 years, and therefore extreme caution should be used before coming to a definite conclusion. The result, however, is larger than can be accounted for by the method of computation. The second section of the paper is an attempt to determine whether the seat of the cause of secular variation is within the earth's crust or outside of it. Two equations are deduced—one of which should be fulfilled if the magnetic system is an external one, and the other if it is internal, the latter giving results in fair agreement with those observed, while the former does not. The author concludes that the main cause of the secular variation of the earth's magnetism is due to a system of forces embedded in the earth, and not to an external system, though an external system may produce minor effects. The third section of the paper is a preliminary note to a new mathematical analysis of the earth's magnetic field, upon which the author is at work.—*Abstracted from Terrestrial Magnetism and Atmospheric Electricity* (*Baltimore*), *September.*

Heat Transference through Boiler Plates.

This paper gives the results of an investigation conducted by the Physikalische Reichsanstalt into the passage of heat through metallic plates. It was necessary, first, to develop a suitable method, which was done by Holborn and Dittenberger. The experiments were completed by L. Austin. What has been investigated is the passage of heat from oil to water, or from water to oil, through an iron wall three centimetres in thickness. A certain transition resistance has to be overcome when heat passes from a solid wall to a liquid. The transition resistance is not so great as in the case of solids and gases, yet it is generally larger than the resistance which the metal itself offers to the passage of heat. The apparatus consisted of a small boiler of wrought iron, having two chambers separated by the plate to be investigated. Each chamber contained a stirrer, a suitable thermometer, and was heated by Bunsen burners. The dividing partition was drilled to receive thermocouples, by means of which the temperature gradient in the iron plate, and between the iron and liquid, could be determined. One of the first effects to be noticed was the decrease in the difference in temperature between the surface of the plate and the liquid, when the stirring apparatus was put into service. This difference decreased with increase in the speed of the stirrer, apparently approaching a limit. Measurements were made of the heat passing from the plate into the water, and in the reverse direction. The following results were obtained: with a heat flux from metal to water, the transition resistance varies between 1.2 and two centimetres of iron, according to the degree of boiling in unstirred water. Stirring reduces it to 0.75 centimetre. If the water is only warm, the resistance may be equivalent to ten centimetres, which, by stirring, is reduced to one centimetre. When the water is not boiling, the resistance increases somewhat with a decrease in temperature. With a heat flux from water to metal, the transition resistance is constant with different temperatures, and is greater than with the reversed flux when the water is not stirred, and as great as with the reverse flux when the water is stirred. If the transition resistance be due to a film of water adhering to the iron that film should have a thickness of about 0.1 millimetre, since iron conducts 100 times better than water, and since a maximum resistance for water of ten centimetres was observed. The thickness of this film is independent of the condition of the surface of the iron, as cleaning had no effect. It is thought that the vibration of locomotive boilers may have an effect somewhat analogous to mechanical stirring, and this would account for the better results obtained from such boilers, than from stationary boilers. While mechanical stirring would assist in raising the steam in boilers, its application seems to be impractical.—*Abstracted from Engineering* (*London*), *January* 1.

The Distribution of Light from Incandescent Lamps.

In this article Mr. L. W. Wild presents a study of the distribution of light from incandescent lamps, and suggests a system of rating. The distribution of light from an incandescent filament, when not disturbed by the enclosing globe, is greatest in that direction which shows the greatest apparent length of filament; but this distribution may be affected by reflection from the glass globe. So marked may this effect be that rotating the lamp through only a small angle may increase the light falling upon the photometer by as much as fifty per cent. This effect is less marked with the filaments of the form now generally manufactured, and is less likely to be found in a direction normal to the mean plane of the filament—the direction which gives the greatest illumination, and in which measurements may be made with the least error, due to incorrect setting of the lamp. The candle-power measured in this direction the au-

thor designates as the normal candle-power, and he suggests that it be used in comparing lamps, rather than the mean spherical or mean horizontal candle-power. The mean spherical, while theoretically most reliable, is tedious of determination, while the mean horizontal he does not consider reliable. On the other hand, the normal candle-power can be determined by two readings, taken from opposite sides of the lamp; and as, in this direction, no shadows are thrown by the filament, the reading is proportional to the total amount of light given out, and therefore proportional to the mean spherical candle-power. He gives a table showing the various readings obtained from eight lamps having filaments of different forms. As a means of comparison, the readings are reduced to a standard of ten candles measured as the normal candle-power. The mean spherical candle-power of the various lamps is then found to vary from 8.3 to 8.45, while the mean horizontal candle-power varies from 9.9 to 9.25. The ratio of mean spherical to normal candle-power varies from 8.3 to 8.45.—*Abstracted from the Electrical Review (London), January* 1.

The Value of Manual Training.

This is a more detailed study of the comparative value of manual training, as obtained in trade schools, and shop training, than was given by the author, Mr. James Mapes Dodge, in his recent address before the American Society of Mechanical Engineers. He starts with boys sixteen years of age, each of whom can obtain work at $3 per week. One set goes into the shop; the other takes a three-year course at a trade school. The potential or invested value of each—that is, the value on which his weekly wages amount to five per cent—is $3,000. The shop-trained apprentice receives an increase in wages of sixty cents per week for each six months of service, until he reaches the age of nineteen and one-half, when his wages are $7.40 per week. They are raised to $9 a week at the age of twenty, and to $13.20 per week at the age of twenty-one and one-half, finally reaching $15 per week at the age of twenty-four. The graduate of the trade school, leaving the school at nineteen, can command a wage of $12 per week. He is then two years ahead of the shop-trained apprentice, or his invested value is $12,000, which is more than $5,000 greater than that of the shop-trained boy of the same age. His increase from this point is less rapid, but he reaches a wage of $15 per week—the maximum reached by the shop-trained—at twenty and one-half years, and is then three and one-half years ahead of the latter. His wages at the age of twenty-five are $22 per week, and his invested value is $22,000, an increase of $19,000 in nine years; and from this point he continues to rise. His average yearly increase in value at the age of twenty-five has been $2,100 per year, as compared with $1,300 for the shop-trained. The author says that of all the trade school boys he has employed, only one per cent have failed completely. The rest are still with his company and have advanced, or have left for better situations. Of the shop-trained boys, only five per cent rise above $15 per week. Thirty-five per cent remain in the employ of the company indefinitely, without rising above this point; twenty per cent leave of their own accord, and forty per cent are dropped gradually.—*Abstracted from the Manufacturer (Philadelphia), January* 1.

Electrical Speed Indicators.

A number of interesting attempts to develop an electrical speed indicator are here described by Mr. A. S. Cubitt, though all but one were unsuccessful. The first attempt consisted in interposing a make and break in a circuit comprising an ammeter, a battery and a resistance; but it was found that, beyond a very small range, the value of the current remained stationary for all speeds, owing to the fact that duration of the contact varied inversely as the number of contacts per second, so that the average duration of contact per second remained the same. An attempt was then made to construct an apparatus in which the energy imparted to the moving part of the indicator during each contact would remain constant. The indicator consisted of a flywheel operated by an electromagnet, acting upon pawl and ratchets, and the current through which was made or broken by a contact upon the apparatus, the speed of which was desired. A retarding brake, consisting of a permanent magnet and a copper disc, was first used, but this was not satisfactory and was replaced by a hysteresis brake, which gave a satisfactory calibration curve; but the life of the apparatus was barely twenty-four hours. In the next attempt a low-reading ammeter was connected in series with a battery and a resistance coil. The terminals of the ammeter were short-circuited by a relay which was actuated by a make and break on the moving axle. The moving part of the ammeter was weighted. The instrument was satisfactory in the laboratory, but the contacts wore rapidly and made it unsuitable for practical use. Another device was driven in an ingenious way by means of what the author calls an electromagnetic ratchet. A conducting disc is spanned at the outer edge by an electromagnet. This attracts an armature consisting of two parts, so arranged that the magnetic flux set up through the armature by the magnet passes through the disc. When an intermittent current is passed through the magnet, it attracts the armature, which is set into vibration; but, as in its motion toward the magnet the flux passing through the disc is considerably greater than when it flies back, a resultant torque is set up on the disc, tending to revolve it continuously in one direction. This instrument worked nicely, but the deflections were too small to make it of value. The plan of using a short-circuited ammeter was then returned to, the short-circuit being made and broken by a contact on the revolving axle. This was satisfactory, but did not wear well, though it led to the following satisfactory device: the galvanometer was replaced by two pairs of coils placed at right angles, and attracting at the centre an iron needle. A constant current was passed through one pair of coils, and an intermittent current, made and broken by a cam upon the revolving axle, was passed through the other two. This instrument is independent of the applied voltage, and the pointer takes up an angular position whose tangent is proportional to the number of revolutions of the cam.—*Abstracted from the Electrical Engineer (London), January* 1.

Electrical Developments in Austria.

The British consul at Trieste reports that the Kerka (Dalmatia) electricity works, developing 20,000 horse-power, will be opened shortly. Power will be transmitted to Sebenico, where a calcium carbide works has been erected. The transmission line will be seven and one-half miles long. The central station at Jaruga contains two 3,500-horse-power sets, and it is anticipated that the annual production of carbide will be 5,000 tons. The consul states further that the company formed for the utilization of water power of Dalmatia, under the name of the Società Romana, has also commenced operations on the Manojlovac waterfall, from which it is hoped that 25,000 horse-power will be obtained. There will be altogether 30,000 horse-power from the four Kerka falls, and the annual production of calcium carbide will be 30,000 tons. The total capital employed will be over $1,750,000.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The General Electric Company at the New York Automobile Show.

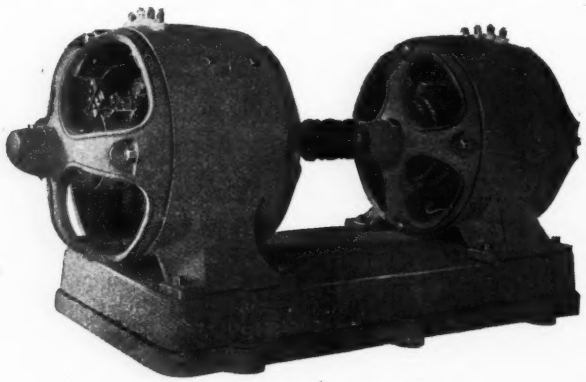
The General Electric Company, Schenectady, N. Y., made an elaborate exhibit at the National Automobile Show, which was held in New York city, at Madison Square Garden, from January 16 to January 23. The exhibit consisted of electric motors of new and improved design, a motor-generator charging set, a large and small lamp, steering check, a controller for electric vehicles using one motor, a standard controller for vehicles using two motor equipments, a charging panel, switchboard, rotary converter, and a mercury rectifier.

NEW TYPE G. E. AUTOMOBILE MOTOR.

NEW TYPE G. E. AUTOMOBILE MOTOR.

The General Electric Company was one of the earliest electrical manufacturing companies to enter the automobile field, and has always taken a leading position in attractiveness of design and in advanced ideas in mechanical and electrical construction. The small bipolar machines, mounted in laminated cases, which were put into commercial use about five years ago, and which were known as the CY-14 type, were followed by the GE-1001 and GE-1002 types, rated, respectively, at twelve and one-half and twenty amperes, eighty-five volts. The next types put on the market were the GE-1004, GE-1005, GE-1007 and GE-1008. This line of standard motors comprised four sizes, wound, respectively, for ten, sixteen, twenty and thirty amperes.

As the result of the experience gained with these motors it was determined to design an entirely new line which would show improved design, greater care in the relationship of speed and torque characteristics and more flexibility of application to the vehicle and some decrease in weight.



MOTOR-GENERATOR CHARGING SET.

STANDARD CONTROLLER FOR AUTOMOBILE SERVICE.

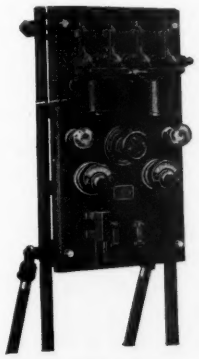
The new six-pole General Electric automobile motor, known as the GE-1010 and GE-1011, which was exhibited for the first time, approaches very nearly to theoretical possibilities in its speed, torque and efficiency characteristics and the relationship between them. The torque for a given current is relatively high and increases in correct proportion as the current increases. It also keeps up its efficiency when a large torque is required, such as starting, hill climbing, or running on bad or muddy roads. Experience will prove that this type of motor will result in a very considerable saving in battery maintenance.

The GE-1011 and 1012 show a decrease in weight over the GE-1004 and GE-1008, respectively, which they succeed.

The field rings of this new class of motors are made of cast steel. The pole-pieces are of laminated iron and the coils are machine wound and thoroughly waterproof. The commutator segments of the armatures are deep and wide, giving a high conductivity and perfect radiation

of heat at overloads as well as ensuring long life and freedom from sparking.

In order to decrease the cost of repairs the armatures of these motors have been built on quills so as to facilitate removal. The oil ring bearings have been standardized in a form similar to those so successfully employed in street railway service. The shafts have been made of a specially high grade of steel and the journals are large, ensuring minimum attention, and are protected from dirt and grit by a perfected form of dustproof packing.



CHARGING PANEL.

As many parts as possible of these new motors have been standardized and are, therefore, interchangeable. Any size of motor may be fitted with or without axle arms, according to the desire of the customer as to the method of suspension.

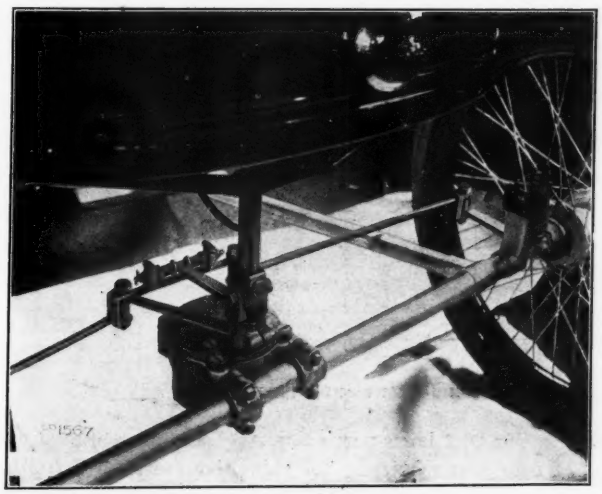
The charging panel shown in the General Electric Company's exhibit is fitted for one two-horse-power, three-phase, sixty-cycle induction motor connected to a one-kilowatt 110-volt generator. The equipment of this panel consists of a four-pole circuit-breaker; two lamps, with bases to be used as polarity indicators; one pocket volt-ammeter, ten amperes capacity; one pocket voltmeter, with 120 volts capacity; one starting rheostat; two fuses; one plug switch and one resistance for low-voltage coil.

To supply the demand for a small charging set for automobiles, that can be operated by any standard single-phase circuit, the General Electric Company has placed on the market a single-phase, self-starting rotary transformer that can be operated successfully on both 60 and 133-cycle circuits.

This type of single-phase rotary is self-starting, with less than full-load current, and the starting mechanism is automatically changed from the starting to the synchronous running position.

The present standard outfit will give the following range of electromotive force without the use of resistance: 90 to 120 volts, 45 to 60 volts, at full load current.

For localities where the owner of a small electric automobile has great difficulty in arranging charging facilities, or the expense and care of a gas engine or motor-generator is too great to be considered, the General Electric Company has developed a mercury rectifier suitable for charging the common runabout of twenty or thirty cells under all ordinary conditions of usage.



STEERING CHECK.

The two principal features of the rectifier outfit are, first, a vacuum tub in which the conversion takes place, and second, a reactance, the function of which is to secure stability of operation and to give a ready means of varying the load.

The capacity of this rectifier is ten amperes, this being the rate at which an automobile, in case it is fully run down, may be safely left charging all night. Inasmuch as the rectifier is so simple to operate and requires no attention, there should be little excuse for vehicle owners ever being caught with an empty battery. If, during the time of charging, the power should go off, charging ceases, to automatically recommence as soon as the circuit becomes alive again.

A Device for Facilitating Telephonic Communication.

One of the most welcome innovations in the line of telephone accessories would be a practical and handy telephone reference for instant use. A number of devices in the shape of flexible pads, cylindrical lists, and in other forms, have been put upon the market, and have served this purpose with more or less success.

TELEPHONE CARD DIRECTORY.

The accompanying illustration shows a new form of telephone directory which has been invented by Mr. M. Holtz, of 200 Greene street, New York city. This directory is in the form of a nickel bracket which may be clamped to the post of the portable telephone apparatus, and contains cards arranged as in a card index, permitting any classification—by business, alphabetically or in any other way to suit the convenience of the user. A card may be withdrawn and any number of names of the same general classification, up to the capacity of the card, may be seen at a glance, the card dropping back to its place by its own weight. The projecting tabs on the cards give an instant guide to the contents, and permit the ready withdrawal of any card.

Overhead Trolley System in Monaco.

The principality of Monaco, in southern France, has had an electric railroad operating on a surface-contact system since 1898. Recently permission has been secured to use a trolley system for extensions to the line, and it has been decided to convert the whole system, although the original road has given satisfaction. The power station has an output of 220 kilowatts at 500 volts, and there are six motor cars, each equipped with two motors.

High-Power Westinghouse-Parsons Steam Turbines.

The commercial introduction of the steam turbine for general power service is one of the most prominent engineering subjects of the day. Within very recent times there has been a most remarkable development, not only in the efficiency of the machine, but also in its increased power capacity. As a result of numerous tests and careful investigation, the steam turbine is coming to be regarded as a most reliable factor in the production of useful power. The Westinghouse-Parsons steam turbine was commercially introduced during the closing six months of the last century. The sizes then built were of 600 horse-power nominal capacity, direct-connected to 400-kilowatt polyphase generators. Subsequent development has been so rapid that, within a period of four years, turbines of 5,500 kilowatts or 7,500 horse-power nominal capacity have been designed and are under construction. These machines will have a continuous overload capacity of 11,000 horse-power in one self-contained unit, thus ranking among the world's largest prime movers.

Recently marine work has been contemplated by the builders, and the near future may be productive of turbines of still greater power, although of slightly different arrangement, necessary to adapt the present type to marine usage.

The 5,000-kilowatt turbo-generating unit, shown in the accompanying illustrations, is representative of the general type which will be constructed for large powers. This type embodies the experience acquired in the construction and operation of a large number of machines. The principle of operation, as well as the general relation and arrangement of rotating and stationary elements characteristic of former types, has been employed.

The most distinguishing features of the new type are the extreme compactness and low speed secured. These features have been practically prescribed by the necessity of minimizing the cost of power-building construction for larger station capacities.

The space occupied by the 7,500-horse-power turbine is approximately twenty-seven feet eight inches by thirteen feet three inches, and the height to the top of the hand-railing is twelve feet. This is equivalent to 0.049 square foot (less than one-twentieth square foot) per electric horse-power capacity, or 20.2 horse-power per square foot of floor area required.

For the complete unit a rectangular area of forty-seven feet four inches in length and thirteen feet in width is required, which is equivalent to 0.084 square feet per electric horse-power capacity, or twelve electric horse-power per square foot of floor space.

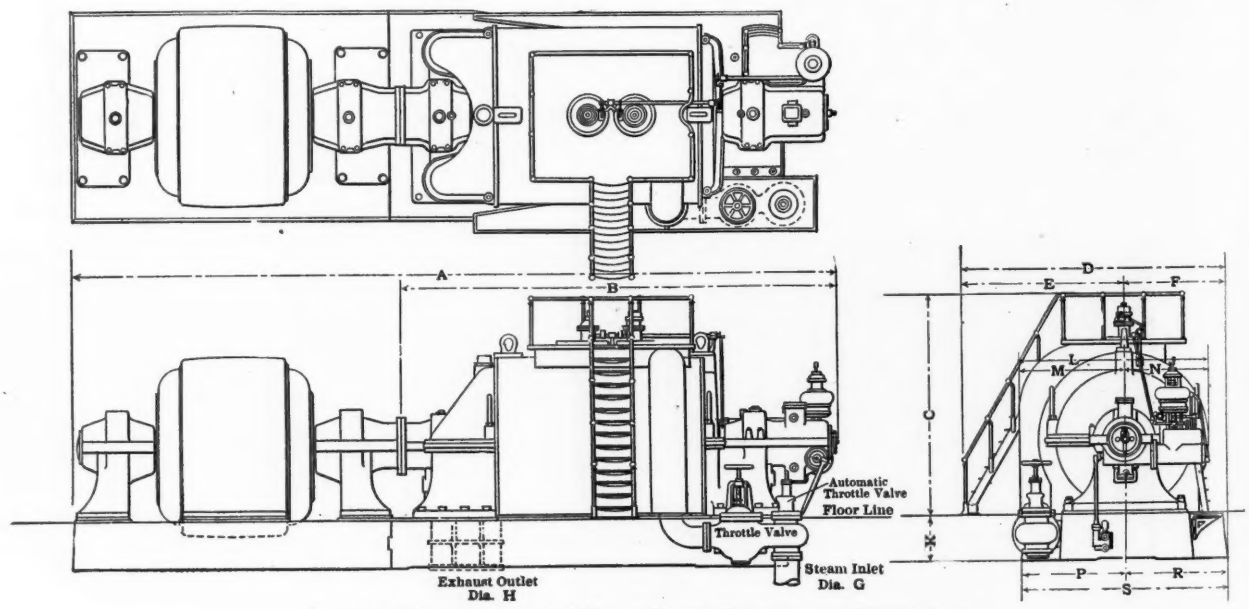
In point of speed, the new type fulfils the demand for a unit operating at moderate speed. The 5,000-kilowatt units operate at 750 revolutions per minute, the 2,000-kilowatt unit, 1,200 to 1,560 revolutions per minute, and the 1,000-kilowatt unit, 1,500 to 1,800 revolutions per minute, depending upon the frequency desired. These speeds, although not comparable to engine speeds, do not impose much greater stresses upon the rotating parts, and in addition secure the great advantage of reduction in the bulk, weight and cost of the unit.

The accompanying plan and elevation of the 5,000-kilowatt unit shows the general arrangement of the main cylinder body, bearings and auxiliary parts.

The unit rests upon a single bed-plate cast in two sections, which are secured by shrunk links. To the bed-plate, which is heavily ribbed to secure rigidity, are bolted the pedestals, generator casing and turbine body, but the bed-plate itself is not secured to the foundation by other means than the weight of the unit. Steam and exhaust connections are made beneath the floor level.

In the smaller machines of this type the cylinder barrel and both journals are cast in a single casting, thus largely minimizing machine work. In the large machine, however, the barrel is cast in two sections, united by links, the outboard section carrying the journal and worm casing, and the inboard section, the journal and exhaust opening which extends through the bed-plate. As in former types, linear expansion and contraction of the turbine are provided for by a sliding foot. The inboard journal pedestal is bolted securely to the bed-plate, but the outboard pedestal is free to slide between parallel-machined ways. The main body of the casing is heavily lagged with non-conducting material, secured in place by sheet-steel casings.

Leakage of air from the atmosphere into the exhaust spaces of the casing at the entrances of the shaft is prevented by frictionless packing glands. No oil is



PLAN AND ELEVATION OF 7,500-HORSE-POWER TURBINE AND GENERATORS.

employed, and in consequence the condensation from the turbines is pure distilled water.

In shaft construction great rigidity has been secured with minimum use of metal. A central steel quill carries the entire rotating parts, both blades and balance pistons. Hollow forged steel ends are forced into the two ends of this quill, under hydraulic pressure, and are, in addition, secured by arrowhead links. High-pressure steam is conveyed to all parts of this quill structure in such a manner as to eliminate stresses and consequent distortion due to highly superheated steam.

Power is transmitted to the generator shaft through a flexible coupling which is housed partly by the turbine and partly by the generator inboard journal. The coupling is split at the junction of the two shafts, so that by removing one bearing cap and the coupling bolts either section of the unit may be lifted out without disturbing the adjustment of the remaining section. In the smaller sizes the engagement surfaces of the coupling consist of the squared or hexagonal ends of the shafts, but in the larger machines a crow-foot sleeve is keyed to each shaft and the power is transmitted by an outside quill engaging the crows-foot. Thus great flexibility is secured, together with the greatest facility in dismantling.

The journals in the larger machines are of the solid self-aligning type, similar to that employed in generators and cross-compound engines. The departure from the familiar oil-cushioned journal employed in the small machines is occasioned by the speed reduction secured. The journal shells are babbitt lined and are split horizontally, the two halves being united by bolts with shim adjustment. Oil from a central system is introduced at the centre under slight pressure, thoroughly flushing all parts. Axial adjustment is provided by metal shims arranged in quarter-box fashion. The diameter of the shaft at the journal of a 5,000-kilowatt machine is fifteen inches, strikingly small in comparison to the thirty-four-inch shafts required for a cross-compound reciprocating engine of corresponding capacity.

Longitudinal adjustment to preserve proper side clearance is secured by a thrust bearing located next to the outboard bearing. The bearing is not subjected to longitudinal thrusts from the action of the steam and is consequently of small size.

The two half shells are advanced in opposite directions by graduated set screws, so that the actual running clearances are measured in thousandths of an inch. Once set, these adjustments are permanent and do not require frequent "taking up."

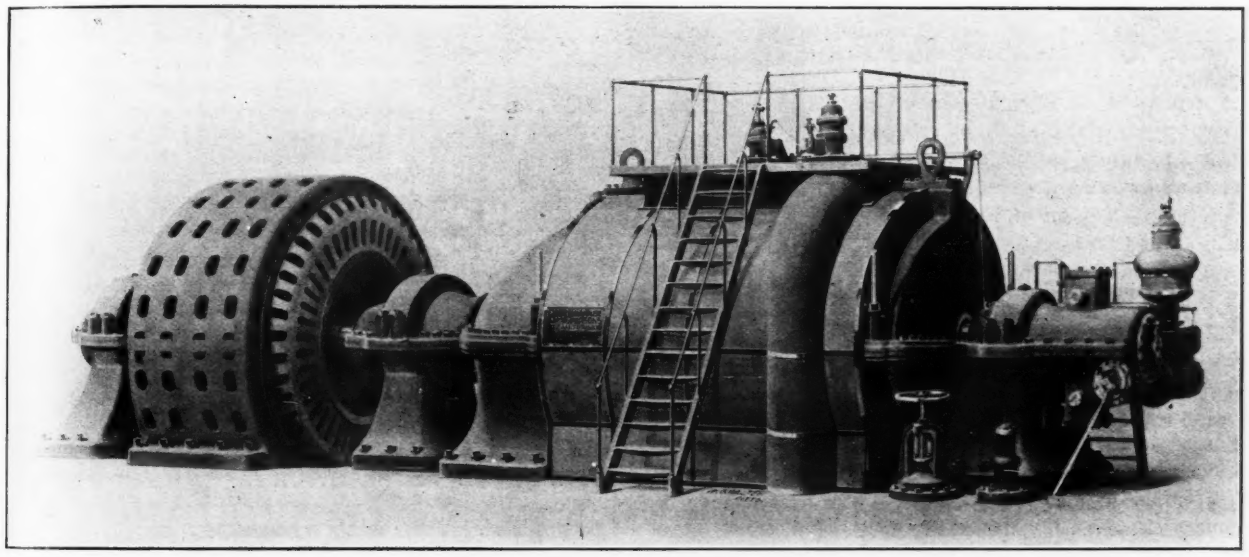
Steam enters the turbine successively through an automatic quick-closing throttle, hand throttle, strainer and the main admission valve. A circular steam port surrounding the entrance to the initial stage conveys this steam to all points so as to avoid stresses incident to more localized admission of highly superheated steam.

An important feature of the steam-distribution system is the provision of a by-pass valve. This valve admits high-pressure steam to the second stage of the turbine on overloads, in order to increase its capacity, up to fifty per cent in excess of full rated load. By properly proportionating the by-pass steam to the overload on the turbine maximum economy may at all times be secured together with reserve overload capacity. This results in a slight rise in the economy curve on heavy overloads, resembling in some respects the engine economy curve on loads exceeding that of maximum economy. The turbine, however, only suffers in economy at heavy overloads, while the engine economy decreases progressively from seventy-five to eighty per cent of full load capacity.

The main admission valve consists of a double-beat poppet valve operated by a small piston, this in turn being controlled by a small pilot valve directly actuated by the governor mechanism. The valve admits steam to the turbine in puffs, the duration of which is proportioned by the governor to the load upon the turbine. This intermittent method obviates the throttling of steam to accommodate loading and secures the highest economy by using at all loads steam at boiler pressure.

At the extreme outer end of the turbine shaft is mounted a worm driving a short horizontal cross-shaft. This shaft drives at one end the oil pump and at the other end the governor through bevel gearing. An eccentric provides the reciprocating motion necessary for the valve mechanism.

The governor is of the fly-ball type, with ninety-degree bell, crank ball levers mounted on knife edges and fitted with roller contacts. The governor sleeve and spring is mounted on ball bearings and adjustment of the spring tension may be made while the turbine is running, thus affording a most simple and convenient means for paralleling alternating-current



A 7,500-Horse-Power Steam Turbine and Generator.

generators and dividing the load proportionately between them.

At the extreme end of the outboard pedestal is mounted an auxiliary speed-limit governor. It is likewise of the centrifugal type and may be set to release, at any predetermined speed, a small plunger valve which controls with high-pressure steam the operation of the quick-closing throttle before mentioned. This is normally held open by means of an over-balanced differential piston. At the moment the speed limit operates, the excess pressure is removed and the throttle closes. This device is employed purely for ensuring immunity from accident from excess speeds, due to the possible disablement of the governor mechanism.

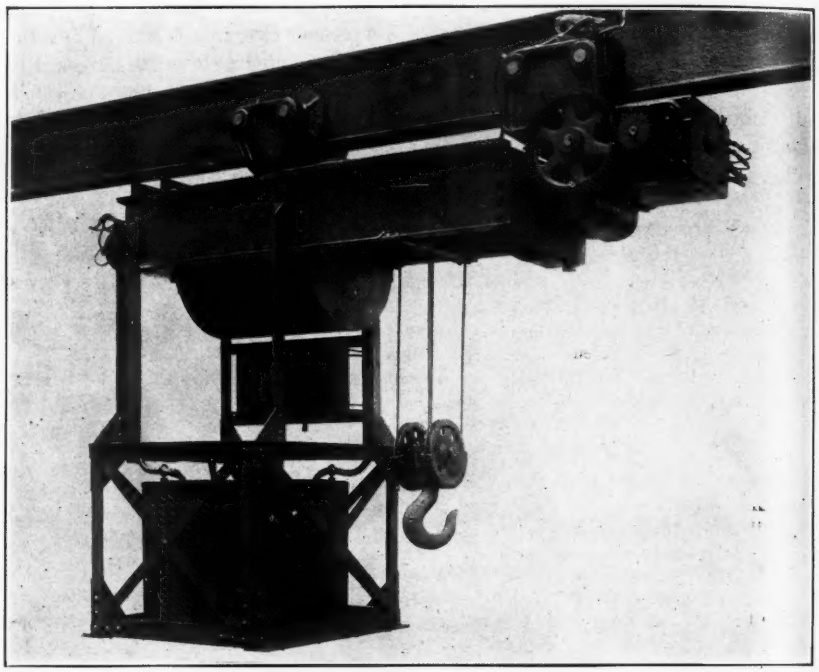
Copious lubrication is supplied to all journals by means of a plunger pump driven from the worm shaft. The warm oil returning from the bearings passes through a copper coil cooler in the bed-plate and thence to a reservoir from which the pump draws its supply. The cooled lubricant is circulated at slight pressure, sufficient to ensure positive flow. At no point is oil under high pressure employed for preventing erosion of rubbing parts, bearing areas being sufficient for supporting the weight of the rotating parts.

In general construction the 5,000-kilowatt turbo-generators conform to those now building for smaller machines. The field or revolving element is built from a solid cylinder of steel slotted for the reception of the bar windings, and provided with ventilating openings corresponding with openings in the laminations of the stationary element. The generators may be wound for high voltage if desired, in order to avoid the use of step-up transformers in a system of power transmission at voltages ranging up to 15,000.

The 5,000-kilowatt turbo-units here illustrated will be employed in heavy electric railway service, which is the most exacting encountered in central station operation. These machines will form the initial equipment of the Pennsylvania Railroad terminal property in New York city; operating with electric locomotives the heaviest Pullman trains through the tunnel approaches to Manhattan. Three units will similarly inaugurate the power service on the Philadelphia Rapid Transit subway system now under construction. Eight 5,000-kilowatt units will furnish power to the London subway system and three 3,500-kilowatt units to the surface system of the same city. These units will operate under 175 pounds steam pressure, high vacuum and 100 to 175 degrees of superheat.

A New Electric Traveling Hoist.

The accompanying illustration shows the new Niles electric traveling hoist built by the crane department, Philadelphia, Pa., of the Niles-Bement-Pond Company. These hoists may be equipped with a cage, as shown, or they may be arranged to be operated from the floor by means of pendant controllers. The hoisting mechanism is placed between the channel framing of the trolley, and is direct-geared to the drum, a standard load and motor brake being provided. The power for hoisting in all cases is furnished by electric motors, while the trolley travel may be arranged for by motor or hand racking.



A New Electric Traveling Hoist.

This type of hoist is built in three sizes, of three, four and ten tons capacity. Swivel trucks will be furnished for use on curved tracks. The New York office of the Niles-Bement-Pond Company is at 136 and 138 Liberty street.

Test of a 4,000-Horse-Power Turbo-Generator.

It is reported that the 4,000-horse-power Brown, Boveri-Parsons turbo-generator installed in the power station in Frankfort-a-M., Germany, was recently tested. Steam was supplied at about 186 pounds per square inch, superheated to about 300 degrees centigrade. With a power-factor of eighty, the turbo-dynamo has an output of 2,600 kilowatts at a speed of 1,360 revolutions per minute and at a pressure of 3,000 volts. The overall length of the set is fifty-four feet, the maximum height and width not exceeding eight feet three inches. Access to the interior is easily obtained by loosening a number of screws and lifting off the top casing. The turbine may be warmed up ready to run in fifteen minutes. The alternators driven by the turbines operate in parallel without difficulty.

The following steam consumptions were obtained, under the conditions named above: with an output of 1,945 kilowatts and a vacuum of 93.2 per cent, sixteen pounds of steam per kilowatt-hour; with an output of 2,518 kilowatts, and a vacuum of 91.8 per cent, 15.75 pounds of steam per kilowatt; with a steam pressure of 152 pounds, superheated to 312 degrees, an output of 2,985 kilowatts, and a vacuum of ninety per cent, the consumption was 15.1 pounds of steam per kilowatt-hour.

The Society of Chemical Industry.

A meeting of the New York section of the Society of Chemical Industry was announced for Friday evening, January 22, at the Chemists' Club, 108 West Fifty-fifth street, New York city. The following papers were scheduled: "Artificial Silk," J. Merritt Matthews; "The Making and Settling of Bleaching Powder Solutions," Martin L. Griffin; "Sun Spot Changes and Their Dangerous Electrostatic Influences upon Explosive Chemicals and Inflammable Gases," Edward Durant.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

FOREIGN ELECTRIC COMPANIES COMBINE—As a result of recent negotiations, it is announced that the Mediterranean Thomson-Houston Company and the German Société Générale d'Electricité have been amalgamated. The new company will have a capital of $1,200,000. There has been no conclusion of the negotiations for the amalgamation of the French Thomson-Houston Company into the combination, but no hitch has occurred, so far as is known.

NEW YORK INTERESTS IN BALTIMORE LIGHTING COMPANY—New York lighting interests, headed by Mr. Anthony N. Brady, have been given representation in the directorate of the United Electric Light and Power Company, of Baltimore, Md. The four new members of the board, which was elected January 18, representing the New York interests, are A. N. Brady, N. F. Brady, S. A. Beardsley and T. E. Murray. Mr. A. N. Brady is also made a member of the executive committee.

LONG-DISTANCE TELEPHONE CONNECTIONS—Work has been started on extensions and additions to the United States Telephone Company's long-distance lines. Heavy wires will be strung between Cleveland and Toledo, and these will become a part of a through line from New York to Chicago. As soon as the wires are completed from Toledo to Cleveland, the work of extending them east to Buffalo will be taken up, and during the summer the line will be continued from Toledo west, where it will be tapped by lines running up into Michigan and south through Indiana and Ohio.

WATER POWER PLANT NEAR ALBANY, GA., TO BE ESTABLISHED—It is announced that a water power plant of considerable size will soon be developed at Big Shoals, a few miles north of Albany, Ga. The city of Albany has entered into a contract with the prospective power company to furnish power for the city electric and waterworks. It is proposed to develop from 15,000 to 25,000 horse-power, so that what the city will use will be but a small part of the power which will be at the disposal of manufacturing enterprises. It is expected that the development of this power will prove a great impetus to the manufacturing enterprises in this locality.

INDEPENDENT TELEPHONE COMPANIES RESIST POSTMASTER-GENERAL'S ORDER—The order of Postmaster-General Payne, which bars from the post offices of the United States all independent telephones, has caused considerable bitterness throughout the independent telephone field. The order prescribes that only the instruments of the companies that have long-distance connections with Washington shall be used. In the middle and western states the independent companies have extensive service, and these companies are making a charge of discrimination which is being taken up by congressmen and senators from these quarters. Cleveland, as the headquarters of many of the largest independent companies, has begun a vigorous opposition to the order, and in this it will probably have the aid of the Independent Telephone Association of the United States, and also of the State Telephone Association.

NEW ELECTRICAL UNDERTAKING FOR BRITISH INDIA—A British Indian contract valued at about $200,000 will shortly be let for an electric power installation at Srinagar, Kashmir. Following are some of the particulars regarding the undertaking: 1—A canal taking out of the Sind river and passing along the hill sides to near Ganderbal, at the mouth of the Sind valley. At this point a fall of about 200 feet can be obtained. The water supply in the Sind river is ample at all times of the year except in the winter, and even then will probably be sufficient for the lighting scheme or for the production of about 300 horse-power. 2—A series of turbines, with the necessary pipe lines to bring water down to them, electric generating plant and the necessary transformers, etc. All these will be situated in suitable buildings at the foot of the hill along which the canal runs near Ganderbal. 3—Overhead bare copper wire mains to transmit the power generated to Srinagar, a distance of about twelve miles. 4—A central transformer station outside the city of Srinagar to reduce the voltage to not higher than 2,000 volts. From this point the power will be transmitted to four or more subtransformer stations situated in different parts of the city, and all within a radius of about two miles, at which points the voltage must be arranged to meet the requirements of power machines and electric lighting. Kashmir Durbar proposes to construct the canal. Tenders are invited for all the other works, including the necessary buildings. Firms proposing to undertake the work will be expected to supply detailed estimates and specifications stating exactly the works proposed, the systems to be adopted and the cost. The amount of power to be delivered in Srinagar is about 700 horse-power, but the works must be so arranged that in case of future extensions 1,000 horse-power can be delivered in Srinagar. The maintenance and upkeep of the whole plant for at least one year after completion of the works must be included in the tenders. The bids are invited by the Public Works Department of the state of Kashmir and Jammu. Further details can be secured from the state engineer, Kashmir Durbar, Srinagar, India.

OBITUARY NOTICES.

MR. W. O. GARRISON, president of the Columbia Incandescent Lamp Company, St. Louis, Mo., died on January 17, 1904. Although Mr. Garrison had been ill for some time, his death was not expected, as a few weeks ago it seemed possible that he might recover.

MR. THOMAS H. DELANO, a well-known newspaper man of New York city, died on January 8 at his residence in Greenwich, Ct. Mr. Delano was at one time the publisher of the ELECTRICAL REVIEW, and for a number of years was the treasurer of the New York Press Club.

MR. WILLIAM DUXBURY, head of one of the departments of the Okonite Company, Limited, at Passaic, N. J., died on January 17, of heart failure. Mr. Duxbury was for eighteen years associated with the Okonite Company, and was highly esteemed as a loyal and valuable employé.

DR. GEORGE H. HACHENBURG, who was at one time a well-known contributor to scientific magazines, and who claimed to have originated many of the essential inventions connected with the speaking telephone, died at his home in Austin, Tex., on Friday evening, January 8, at the age of eighty years. He was born in Union County, Pa., and was a graduate of the medical college of New York University, practising medicine in New York state for several years before removing to Texas in 1873. Dr. Hachenburg was probably the originator of the scheme for an aerial or suspended electric tramway system.

THE HON. W. W. SKILES, president of the Shelby Electric Company, whose death at his residence in Shelby, Ohio, was noted in the last issue of the ELECTRICAL REVIEW, was one of the original promoters of the Shelby Electric Company, and was its president from the time of its inception until his death. Mr. Skiles was fifty-four years of age. He was largely interested in, and was one of the founders of, the Shelby Steel Tube Company, the Shelby Cycle Manufacturing Company, the Shelby Water Company, the Shelby Local Telephone Company, the Shelby Stove Company and the Citizens' Bank. He also represented the fourteenth Ohio district in the House of Representatives of the United States. In addition to the business enterprises in which Mr. Skiles was interested, he was senior member of the law firm of Skiles & Skiles, prominent throughout the country by reason of its great success in the prosecution of railroad cases. Mr. Skiles was buried on Wednesday, January 13, and over 10,000 people attended his funeral. The Shelby Electric Company has lost in Mr. Skiles a splendid adviser, and one who, though not actively engaged in the electrical line, had many friends among the manufacturers and large consumers of lamps.

TELEPHONE AND TELEGRAPH.

CARTHAGE, MISS.—B. W. Stewart contemplates establishing a telephone exchange here.

ESCANABA, MICH.—The Finch Telephone Company will extend its line from Escanaba to Menominee.

ONTARIO, N. Y.—The Empire State Telephone Company purposes to erect a local exchange in this town.

FRANKFORT, MICH.—The Benzie County Telephone Company will make many needed improvements the coming year.

BOWERS, PA.—The American Telegraph and Telephone Company has completed the line between Pricetown and Monterey.

MECHANICS FALLS, ME.—The Poland Telephone Company is extending its lines to East Poland, Minot Corner and Hackett's Mills.

NEWARK, N. J.—The People's Rural Telephone Company, with headquarters at Wenonah, will begin the construction of its lines at an early date.

STAMFORD, N. Y.—The Oneonta Telephone Company will install an additional switchboard, which will give it a capacity of 1,000 subscribers.

BIG TIMBER, MONT.—A movement is on foot to establish a rural telephone system among the ranchers residing between Big Timber and Melville, twenty miles north.

DANVILLE, ILL.—The Washington City Rural Telephone Company has purchased the Washington telephone exchange from the receiver of the Peoria & Eastern Telephone Company.

SALISBURY, N. C.—The Southern Bell Telephone Company has purchased the Salisbury and Spencer system owned by W. F. Snider and others. The two systems will be enlarged and greatly improved.

LINCOLN, ILL.—The Central Illinois Telephone and Telegraph Company has completed its line between this city and Bloomington *via* Clinton. The line has been in the course of construction for some time.

STEUBENVILLE, OHIO—The new telephone company of Brilliant, Mingo and Portland will build a line along the river front of Jefferson County, to connect with the independent companies of the Ohio valley.

COLUMBUS, OHIO—The Yoker Valley Telephone Company has been incorporated by W. W. James, J. Wyscaron, N. P. Hartly, W. G. Long and H. D. Long. The company will install an exchange at Quaker City.

WASHINGTON, D. C.—The board of directors of the Chesapeake & Potomac Telephone Company has voted to expend $1,750,000 on improvements. With that sum they hope to give the city better service.

GORHAM, N. H.—The Ammonoosuc Telephone Company has been incorporated to run a telephone line between Groveton and West Milan. The poles are being set, and the line will be in operation within a few weeks.

DES MOINES, IOWA—The Valley Junction & Orilla Telephone Company has been organized to build a line from Valley Junction to the town of Orilla. R. J. Houtz is president; C. H. Taskett, vice-president, and F. Clark, secretary.

LIMA, OHIO—F. S. Dickson, of the Federal Telephone Company, has completed negotiations for the sale of the controlling interest of the Lima Telephone Company, now owned by the Federal company, to a syndicate of Lima business men.

KINGSTON, N. Y.—The West Shore Home Telephone Company has made a connection from Smith's Landing to Saugerties, and will immediately extend its system so as to connect Catskill, Saugerties, Kingston, Poughkeepsie, Newburgh and the Wallkill valley.

SCRANTON, PA.—The Bradford County Telephone Company has its line completed to Laceyville, where it connects with the line of the Tunkhannock & Wyoming Company, which extends to Pittston, where connection is made with the Consolidated Telephone Company.

EARLVILLE, N. Y.—The Earlville Telephone Company is to extend its line toward Waterville, and the Waterville line will be built to meet it. When connected it will afford a complete circuit into Utica, where connections will be made with the Home Telephone Company.

STAMFORD, N. Y.—The Hudson River Telephone Company has established connections between Kingston and the following places along the line of the Ulster & Delaware Railroad: Phoenicia, The Corner, West Shokan, Shokan, West Hurley, Ashton, Allaben, Shandaken and Pine Hill.

TORONTO, CANADA—The Canadian Telegraph and Telephone Company, which was incorporated at Ottawa at the last session of Parliament, proposes to establish a plant at Toronto. The ultimate intention is to establish a system of local and long-distance lines in Canada, under different names, but under the control of the one company.

GENEVA, N. Y.—The system of the Geneva Telephone Company will shortly be added to so as to give patrons of the local company direct communication with Waterloo and Seneca Falls toward the east. The addition is made possible by the extension of the line of the Home Telephone Company, of Waterloo and Seneca Falls, toward this city.

ROME, N. Y.—At its annual meeting the Rome Home Telephone Company elected the following directors: Fred. M. Shelley, John S. Wardwell, John E. Mason, James S. Brailey, Jr., William T. Grogan, I. H. Griswold and T. M. Brush. The company has at present about 1,000 telephones in commission. Fred. M. Shelley is president of the company; John S. Wardwell, vice-president, and D. Odell, treasurer.

WILMINGTON, DEL.—The Diamond State Telephone Company is installing a new system of telephones throughout numerous small towns in Sussex County, which have heretofore been somewhat isolated. An exchange will be placed at Frankfort, and connections will be made with Bethany Beach, Roxana, Dagsboro, Selbyville, Bayard, Omar, Millville and Ocean View. This will connect a large section of Sussex County, and it is expected that the line will be in operation within a few weeks.

RICHMOND, VA.—The Virginia Telephone Company at its annual meeting reelected all officers with the exception of two, S. M. Torian, of this place, and C. J. Robertson, of Christie, succeeding T. D. Drewry and A. L. Jones. The company now operates, in addition to the exchange in this city, over forty-two miles of wire, connecting at South Boston, Va., with the system there; at Mill Creek, N. C., with the Boxboro system, besides having connections with nearly all the copper mines of the district.

FARMINGDALE, N. Y.—The New York & New Jersey Telephone Company has completed the laying of its underground conduits from Jamaica to this village. The whole distance is twenty-five miles. The line passes under the Jericho turnpike to Queens and under the Jamaica and Hempstead plank road to Hempstead and from there to Farmingdale under the macadam road, traversing the middle of the town of Hempstead. The conduit was completed between Jamaica and Brooklyn two years ago, so that there is a continuous line of conduits from Brooklyn to Farmingdale, a distance of over thirty miles. These conduits, it is said, are intended for the placing of the main trunk cables of Long Island underground, as has been done in Brooklyn and Manhattan, and in some near-by sections of New Jersey. The cables have not yet been placed in the ducts beyond Jamaica.

WILMINGTON, DEL.—The Delmarvia Telephone Company is preparing to place all of its wires underground and renew the equipment completely, using none of the present outfit except the conduits which the company put down some time ago and has been using since. In addition to the present underground service, about 1,000,000 lineal feet of conduit will be laid, which will take care of all of the company's wires. The new equipment will cost between $150,000 and $200,000. It is expected that the plans will be completed in about sixty days, and the work of making the change will be begun as soon thereafter as possible. The new equipment will include additional cable, a multiple switchboard with a capacity ranging from 5,000 to 7,000 instruments, storage battery charging machines, modern instruments and the necessary incidentals. Much of the material has been ordered and is to be delivered as it is needed.

ELECTRIC RAILWAYS.

ROCHESTER, N. Y.—It is announced that work on the Albion Electric Railway Company's line from Lockport to Rochester will be resumed in the near future and carried forward continuously until the road is completed.

CONCORD, N. H.—The Concord street railway and the Concord & Manchester street car line, both managed by the Boston & Maine Railroad, have been consolidated under the name of the Concord & Manchester Electric Branch.

ALLENTOWN, PA.—At a meeting of the directors of the Danville & Bloomsburg Street Railway Company the contract for building the road from Danville to Bloomsburg, a distance of twelve miles, was awarded. The line is to be in operation by July 1.

WARREN, OHIO—The Cortland village council has voted to accept the proposition of the Warren, Cortland & Jefferson Electric Railroad for the location of its power-house there. It will cost $150,000. The village gives a site and $6,500, the company, in return, to light the village.

YORK, PA.—The York County Traction Company has purchased the controlling interest in the Hanover & McSherrystown Street Railway and the Hanover Light, Heat and Power Company. The purchase price was $100,000. The two roads will be immediately merged and form one system.

CHICAGO, ILL.—The Peoria & Rock Island Traction Company, with a capital of $100,000, has been organized to construct a line from Peoria, Ill., to Rock Island, Ill. The incorporators and first board of directors are as follows: W. B. McKinley, Charles Zilly, B. R. Stephens, B. F. Cartwright and J. E. Berry, all of Champaign, Ill.

PARIS, ILL.—The capital stock of the Interstate Railway, Light and Power Company, of this city, has been transferred to the Security Underwriters' Corporation, of Chicago, and the latter company is to construct an electric line north of Paris, which will eventually extend to Danville. Cars are to be running in twelve months.

RICHMOND, VA.—The work of surveying the route for the electric line to be constructed from this city to Ashland has been completed, and the road will be built as soon as possible. It is proposed to run cars at the rate of forty miles an hour, making the trip to Ashland in thirty minutes. The road will parallel the Richmond, Fredericksburg & Potomac Railroad.

CHATTANOOGA, TENN.—The Chattanooga Electric Railway Company will issue at once $1,000,000 thirty-year five per cent bonds, the money to be used for refunding some of the old bonds of the company and for the construction of new lines and improvements to the present system. Extensions are contemplated to Rossville, Ga., Chickamauga park and to the top of Lookout mountain.

DUBUQUE, IOWA—The Interstate Construction Company, which will build an electric line from Dubuque to Platteville, Wis., has filed articles of incorporation. Peter Kiene, of Dubuque, is president. It will cost $750,000 to construct the road, and work will be commenced in March. The survey for the proposed electric line west of Dubuque has been completed, and the work of construction will probably be commenced in the spring.

DANVILLE, PA.—The Danville & Bloomsburg Street Railway Company has purchased the rights, title and interests of the Danville & Riverside Street Railway Company. Through the acquisition of this line the Danville & Bloomsburg company secures the right of way from Danville to Bloomsburg, through Riverside, and it furthermore places the company in a position to make direct connection with a line to be built from Shamokin to Sunbury.

FINDLAY, OHIO—C. B. Metcalf and W. W. and W. H. Drake, of Findlay; G. M. Bailey and Sam P. Douglass, of Toledo, are the incorporators of an electric road to be known as the Lake Erie Traction Company, with a capital of $100,000. The proposed route of the road is along the east branch of the Ohio Central Railway. Starting from Toledo, it will strike Fostoria, Carey, Upper Sandusky, Marion, Delaware, Columbus, and will probably be continued to Cincinnati.

WILKESBARRE, PA.—Work has been commenced on the Hazleton, Weatherly & Mauch Chunk Traction Company's system, which is another link in the proposed third-rail line between this city and Philadelphia, which is now completed from Scranton to this city and this city to Hazleton, and already reduces the time between these points an hour. When the project is completed it is expected that the time between Scranton and Philadelphia will be reduced two hours.

ALTOONA, PA.—Philadelphia capitalists are said to be interested in a project to build an electric trolley line from Altoona to Bedford, Pa. The plan is to touch Holidaysburg, Duncansville, Newry, East Freedom, Roaring Spring, Martinsburg, and through Morrison's Cove to Everett and Bedford. At Loy's Gap, seventeen miles from Bedford, it is the intention to build a summer resort. Power for operating the road will be furnished by the Bedford Water Power and Electric Company.

INDIANAPOLIS, IND.—The Indianapolis & Cincinnati Traction Company's engineers are at work surveying a line that will continue the road from Rushville to Hamilton, Ohio. The new route for the extension will run north of Connersville and leave Liberty ten miles to the south, but will connect Orange, Fairfield and Oxford. At Hamilton the line will connect with a system of roads that will make a straight line from Indianapolis to Cincinnati, with connections to various parts of Ohio.

SPRINGFIELD, ILL.—Articles of incorporation have been issued to the Northern Illinois Traction Company, with its principal office at Mendota. A line will be constructed from Hooppole east to New Bedford in Lasalle County, Ill.; thence in a northeast direction through the counties of Lasalle and Kane to Aurora, in Kane County, Ill. The incorporators and first board of directors are H. B. Allen, Erie, Ill.; W. A. Burkley, Mendota, Ill.; George W. Hamilton, M. A. Booth and W. E. Booth, of New Bedford, Ill.

INDIANAPOLIS, IND.—Work on the proposed line of the Fountain-Warren Traction Company, to connect La Fayette and Danville, Ill., has been commenced, the contract providing for the completion of the line by October 1. The proposed line will run south from La Fayette on the east side of the Wabash river, passing through Shawnee Mound, Newton and Stone Bluff, crossing the river over a bridge to be erected at Covington, and then west to Danville, Ill. Spurs are contemplated from Covington to Veedersburg and from Stone Bluff to Attica.

FREDERICK, MD.—It is reported that the proposed electric railway between Frederick and Baltimore will be built next summer. The delay in the construction of the road, the company states, has been caused by the difficulty experienced in securing a right of way which would enable it to enter the city of Baltimore. This has now been secured, and the company is prepared to go ahead with the construction of the road in the spring. Under its franchise the company has until September, 1904, to have its road completed and in operation in Frederick.

GLOVERSVILLE, N. Y.—The Fonda, Johnstown & Gloversville Railroad Company has purchased the property of the Adirondack Lakes Traction Company, consisting of the trolley line leading from Gloversville to Mountain Lake, and all the hotels and other property at the lake. The road will be run independently of the Fonda, Johnstown & Gloversville system. The following officers have been elected: president, John Shanahan; vice-president, Lyman K. Brown, and secretary, E. H. Steckel. The road will be placed in first-class condition and many improvements will be made at Mountain Lake.

DENVER, COL.—An electric line twenty miles long, extending from Loveland into Estes park, will be built by Denver capitalists. The building of the road will involve an expenditure of not less than $300,000. Much of the preliminary work and some actual construction work have been disposed of, and arrangements are being made to complete the line at the earliest possible date. William A. Riley, Frank G. Bartholf, Greeley W. Whitford, Abner F. Sprague, A. J. Houts, Dewey C. Bailey and Frank S. Tesch are the interested parties. The name of the company will be the Loveland & Estes Park Railroad Company, with a capital of $500,000. It is probable that electric light and power will be supplied to various towns and enterprises along the route.

ELECTRIC LIGHTING.

CLEVELAND, OHIO—The council has approved of an appropriation of $200,000 for a municipal lighting plant.

WACO, TEX.—The power-house of the McGregor Water and Light Company has been destroyed by fire. The loss was about $10,000.

ELKHART LAKE, WIS.—The electric light plant has been purchased by George Brickbauer, who will reopen it and furnish light to the village.

WALTON, N. Y.—The contract for lighting the Andes village streets for one year from December 1, 1903, has been awarded to Barton Gladstone.

LEXINGTON, KY.—It is stated that Franklyn Stone, of Philadelphia, is associated with W. H. McCorkle, of this city, in a plan to establish a new lighting plant.

COLFAX, WASH.—Nicholas Codd, one of the proprietors of the Colfax electric light plant, and James A. Ralph have bought the electric light plant at Dayton for $40,000.

NORWALK, OHIO—C. H. Stewart, of Cleveland, who held a controlling interest in the Bellevue Electric Light and Power Company, has disposed of his interest to John W. Moore, of Cleveland.

WATERTOWN, TENN.—Leading business men are said to be discussing plans for the erection of an electric light plant here. A proposition will be made to the town, which it is thought will meet with its approval.

SEATTLE, WASH.—The current has been turned on at the Vancouver Power Company's electric plant at Lake Beautiful, and the entire electric system of Vancouver is now run by power generated at Trout lake.

HOQUIAM, WASH.—The Gray's Harbor Electric Company is placing two 150-kilowatt alternating-current generators for street railway and power uses; also a 200-kilowatt alternating-current generator for incandescent lighting.

SNOHOMISH, WASH.—The Everett Improvement Company has begun work on a water and electric plant near Wallace, which will harness May creek. The head is 2,000 feet, and it is expected that a large amount of power can be developed.

HILTON, N. Y.—A. M. Lawrence, of Clyde, N. Y., states that if the business men and house owners of this place will support him, he will install an electric light plant. The proposition is said to meet with the approval of those interested.

BIRMINGHAM, ALA.—The electric lights in North Birmingham have been turned on, and the city now owns its own waterworks and lighting plants. These were built with the $60,000 bonds which were authorized at a meeting several months ago.

SALINA, KAS.—The city council of Salina, by a vote of seven to one, granted a franchise for a gas and electric light plant in Salina to Thomas B. Whitted, of Denver. He also has been granted a franchise for building an electric street railway in Salina.

ST. IGNACE, MICH.—George D. Westover, of Cadillac, states that he will apply for a franchise to put in a $20,000 to $25,000 incandescent and arc electric lighting plant, paying the city $3,000 for its old plant. He purposes to have the plant in operation by June 1, 1904.

SAVANNAH, GA.—The Tampa Electric Company will proceed at once to erect a complete new power-house on its property at the mouth of the Hillsborough river. At least $100,000 will be expended in the installation of this plant, which will require nearly a year to complete.

DOYLESTOWN, PA.—The Newtown borough council has awarded the contract for lighting the streets of Newtown borough, for a period of three years, beginning January 8, 1904, to the Newtown Electric Street Railway Company. The price will be $1,827 per year for the term of the contract.

XENIA, OHIO—Charles Darlington and D. M. Stewart, of this city, are endeavoring to interest the citizens of Xenia in a new co-operative electric light company. Both arc and incandescent lights would be furnished, and the company would bid for the street lighting contract. It is estimated that $30,000 would be required.

PITTSBURG, PA.—At a meeting of the Braddock borough council a resolution was adopted providing for the appointment of a committee to enquire into the cost of an electric light plant. It was claimed at the meeting that a plant could be built for $25,000. The light at present supplied to the borough costs about $8,260 per year.

SCRANTON, PA.—Directors of the Suburban Electric Light Company were elected at the annual meeting as follows: William F. Hallstead, A. L. Snowden, George M. Hallstead, E. M. Stack, A. L. Francois and B. Moser. Of these Mr. Snowden was elected president, George M. Hallstead, vice-president, and E. M. Stack, secretary and treasurer.

LEBANON, PA.—The Edison Electric Illuminating Company has elected officers as follows: president, John A. Rigg; vice-president, Remi Remont; secretary, K. A. Fichthorn; assistant secretary and treasurer, Remi Remont; counsel, Simon P. Light; directors, John A. Rigg, Dr. Walter A. Rigg, Richmond L. Jones, J. L. Boyer, Wm. R. McIlvaine, K. A. Fichthorn, S. E. Rigg.

TROY, N. Y.—The Granville Gas, Electric Light and Power Company has acquired rights at the head of the Mettowee river, where lake St. Catherine joins it. The company already has a dam a few miles distant from the head of the river, which, together with the new dam at the head of the river, will form a storage reservoir. Five hundred horse-power can be developed.

PITTSBURG, PA.—The Municipal Light Company, of Pitcairn, has made a statement of its operations for the nine months since it was installed. The plant cost $20,000. The company's total receipts were $3,332.97, and the operating expenses were $2,850, leaving a net surplus for the borough of $482.97. The company has operated fifty-three arc lights for the borough, at $70 per year.

TORONTO, ONTARIO—A company to operate privileges on the Trent valley canal has been incorporated under the name of the Trent Power Company, Limited, with a capital of $500,000. The incorporators are the Hon. S. H. Blake, E. W. McNeill and Robert Gowans, of Toronto, and David Gilmour and Robert Weddell, of Trenton. The head office of the company will be in Trenton.

HAMMONTON, N. J.—The Electric Light, Heat and Power Company, of Hammonton, has sold its electric light plant to the Atlantic County Electric Company. As soon as practical the new company will merge the plant at this place with the electric light plant at Egg Harbor City, making a central distributing plant at the latter point. From there they will supply electricity to Hammonton, May's Landing, Elwood and Absecon. The officers of the new company are Robert Ohnmiese, president, secretary and treasurer, and Thomas T. Mather, superintendent, both of Egg Harbor City. The company has a contract for lighting the streets of Hammonton until January 1, 1907, at $1,800 per annum.

NEW INCORPORATIONS.

LITTLE ROCK, ARK.—The Sharp County Telephone Company. $5,000.

UNIONTOWN, PA.—Fairchance Electric Company; $5,000. Bullskin Electric Company; $5,000.

INDIANAPOLIS, IND.—The Rural Telephone Company. $300. Incorporators: A. Mock, S. W. Combs and W. F. Combs.

ALBANY, N. Y.—The Prattsburgh Overland Telephone Company. $10,000. Incorporators: E. Conine, G. T. Conine and L. H. Conine, all of Prattsburgh.

NORTH WOLCOTT, N. Y.—The North Wolcott Telephone Company. $550. Directors: D. J. Kyle, North Wolcott; J. N. Robertson and A. C. Brink, Wolcott.

AUSTIN, TEX.—The Automatic Telephone Company. $10,000. Incorporators: G. J. Cowden, J. A. L. Camp, G. D. Elliott, E. H. Estes and J. T. Blair, of Midland.

SHELBYVILLE, ILL.—The Shelbyville Water, Light and Heat Company. $50,000. Incorporators: C. C. Scovil, W. H. Beem, Max Kleeman, G. C. Bolinger, I. S. Storm, B. W. Kerr and W. S. Middlesworth.

ALBANY, N. Y.—The Electric Utilities Company. $1,000,000. Directors: Andrew R. McLaren, Alfred H. Townley, George T. Van Valkenburgh, John D. Mason and Thomas J. Snee, of New York city.

PERSONAL MENTION.

MR. DAVID M. EARLE, JR., has been appointed assistant city engineer of Worcester, Mass.

MR. A. C. RAY, of the Smith Storage Battery Company, Binghamton, N. Y., was a visitor to New York last week.

MR. A. A. THRESHER, president of the Thresher Electric Company, Dayton, Ohio, was a New York visitor last week. His company is very busy at present on important government work.

MR. C. F. HEWITT, treasurer and manager of the Elkhart (Ind.) Electric Company and general manager of the St. Joseph & Elkhart Power Company, has tendered his resignation, to take effect February 1, 1904.

MR. E. STUTZ, of New York city, lectured on "Alumino-Thermics" at the Franklin Institute, Philadelphia, Pa., January 20, and will talk on the same subject at the Massachusetts Institute of Technology, Boston, Mass., February 26.

MESSRS. FREDERICK H. COOKE, of Cincinnati, Ohio, and CLINTON D. THURBER, of Philadelphia, Pa., have been nominated by the President to be assistant civil engineers in the United States Navy. These gentlemen were successful in the examination recently held for the position at the New York Navy Yard.

MR. MAX LOEWENTHAL, secretary and electrical engineer of the Prometheus Electric Company, New York, is making a trip through the principal cities of the eastern and middle western states in the interest of the company for the establishing of agencies for the sale of the well-known Prometheus electric heating and cooking apparatus.

MR. W. T. JACKSON, western representative for G. M. Gest, of Cincinnati, New York and Boston, was among the callers at the Chicago office of the ELECTRICAL REVIEW last week. Mr. Jackson is on his return home after a trip to the coast. Business conditions in the conduit line he reports good throughout the whole western country, while future prospects are more than excellent.

MR. WILLIAM H. HEARNE, president of the Wirt Electric Company, Frankford, Philadelphia, was a New York visitor last week. Mr. Hearne is reorganizing the sales department of the Wirt Electric Company, a large interest in which he has recently acquired. The company will increase its facilities, and it is believed that under Mr. Hearne's direction the company will become even a greater factor in its line of manufacturing.

MR. R. H. JOHNSTON, of the office of Ray D. Lillibridge, New York city, is making a good recovery from a case of acute appendicitis. Mr. Johnston was operated upon several weeks ago, and will probably be unable to get into business shape for several weeks. Mr. Johnston has been successful not only as a writer on scientific subjects, but also as a special writer of technical advertising. He is a member of Cornell and Columbia fraternities.

MR. ERNEST H. DAVIS, secretary and treasurer of the National Electric Light Association, was a visitor to New York last week, looking after association affairs. Mr. Davis reports that the association is in a very flourishing condition. The programme for the twenty-seventh convention is being rapidly formulated, and will contain a number of novel features. The question box, in the hands of Mr. H. T. Hartman, is already well filled with queries, but there is room for many more, and it is hoped that members will avail themselves freely of this means of gaining useful information.

MR. ALEX DOW, of Detroit, Mich., was elected president, and Mr. William Chandler, vice-president, of the Edison Sault Electric Company, by the directors on January 15. The following directors were chosen: William Chandler, Sault Ste. Marie, Mich.; Henry W. Darling, Schenectady, N. Y.; Alex Dow, Detroit, Mich.; Alfred Jaretzki, New York city, and Frank P. Sullivan, of Sault Ste. Marie. Messrs. Dow, Jaretzki and Sullivan are new names on the board, and represent a change of control of the property. It is understood that Mr. Dow will be the active representative of the new interests. His residence in Detroit is sufficiently near to permit of effective supervision. Mr. Dow is well known as a manager of other electric illuminating properties, more particularly the Edison electric light properties in Detroit. At the same meeting the stockholders authorized an increase in the capital stock from $57,000 to $150,000.

MR. M. G. HUBBARD, who has been recently elected secretary and treasurer of C. E. Hewitt & Company, engineers and contractors, Park Row Building, New York city, was for thirteen years engineer and general superintendent of the McGuire Manufacturing Company, Chicago, Ill. For the last three years he has been engaged in exporting railway supplies at 114 Liberty street, New York city. While with the McGuire Manufacturing Company he spent considerable time on the road, and became well known in electric railway circles. Mr. Hubbard is well fitted for his new business connection, by experience and training, and his many friends will wish him success in this line.

ELECTRICAL SECURITIES.

There has been considerable talk in stock market quarters to the effect that, if the apprehension of a war between Russia and Japan were removed, the conditions of the market are such that there would follow a good rally. It is getting about as tiresome to predict either war or peace as it was some months ago to offer the prediction of a change in the market, which was then on a continuous decline. There is no doubt, however, that the uncertain state of affairs which holds forth in foreign centres, due to the diplomatic negotiations between Russia and Japan, is felt with more or less force in the United States markets.

The industrial situation, as far as labor troubles are concerned, seems to be clearing, and employers and employés are coming nearer to a definite understanding of their respective claims. The approach of a presidential campaign is always more or less of a check upon the market activity, and, although the small buyer as an individual is not relatively significant, still, in the aggregate, the commissions executed for him amount to a factor which means the advance or decline of a number of leading industrials. It is unfortunate that there are, at the present time, so many circumstances to militate against an advancing market. On the other hand, the fact that an advance has been made and maintained, despite these untoward conditions, has promoted a strong faith in the inherent stability of securities in general.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JANUARY 16.

New York:	*Closing.*
Brooklyn Rapid Transit	48½
Consolidated Gas	192⅜
General Electric	174
Kings County Electric	184
Manhattan Elevated	142¼
Metropolitan Street Railway	121
New York & New Jersey Telephone	147
Westinghouse Manufacturing Company	192

Boston:	*Closing.*
American Telephone and Telegraph	125
Edison Electric Illuminating	235
Massachusetts Electric	77½
New England Telephone	122
Western Telephone and Telegraph preferred	79½

Philadelphia:	*Closing.*
Electric Company of America	8¼
Electric Storage Battery common	56
Electric Storage Battery preferred	56
Philadelphia Electric	6¼
Union Traction	46
United Gas Improvement	86½

Electric Company of America directors have declared a dividend of three per cent (thirty cents per share), payable January 30 to stock of record January 20.

Chicago:	*Closing.*
Chicago Telephone	123
Chicago Edison Light	148
Metropolitan Elevated preferred	52
National Carbon common	24
National Carbon preferred	92
Union Traction common	5
Union Traction preferred	30

The Chicago Edison Company has declared a quarterly dividend of two per cent, payable February 1 to holders of record January 23. Books close January 23 and reopen February 1.

INDUSTRIAL ITEMS.

THE RAILWAY AND ELECTRIC EQUIPMENT COMPANY, of Philadelphia, Buffalo and Chicago, has withdrawn its Cleveland office, and has no representative in Cleveland at the present time.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, is distributing an attractive booklet entitled "Good Motives." This describes the line of Peerless motors manufactured by this company, and shows a number of typical adaptations to machine tools and other apparatus.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., reports a brisk demand for No. 521 "Midget" plug and receptacle, which occupies very little space and is adapted to old work or conduit boxes. The company has recently received an order for 1,000 of its well-known "Dow" adjusters for export to South Africa.

THE SPAULDING PRINT PAPER COMPANY, INCORPORATED, 44 Federal street, Boston, Mass., describes the "Federal" blue-print machines in a new bulletin, which it will be pleased to send on request. This is an improved apparatus for making blue-prints by both sun and electric light, without the use of plate-glass.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is starting the new year with renewed enthusiasm to push the sale of "D. & W." enclosed fuses and safety apparatus. The company states that the popularity of "D. & W." material has been steadily growing, with a constantly widening field. There is every reason to believe that the coming year will witness a largely increased sale.

THE NEWTON MACHINE TOOL WORKS, Philadelphia, Pa., in its catalogue No. 37 describes a line of rotary planing machines. The text is supplemented by a number of fine half-tone illustrations of these planing machines. Several of the machines are motor-driven, this equipment making a remarkably compact and powerful apparatus.

EMIL GROSSMAN, 298 Broadway, New York city, manufacturer, importer and selling agent of automobile accessories, has produced a very complete catalogue for the season of 1904. Among some of the supplies listed are acetylene lamps of various types, generators and lamp sundries, automobile horns, imported goggles, spark plugs, "Packard" cable, tires and tire repair outfits. This catalogue will be supplied on request.

THE S. H. COUCH COMPANY, 156 Pearl street, Boston, Mass., manufacturer of telephone specialties, in a new folder describes the "Work Well" telephones. This is an intercommunicating apparatus, and is equipped with two and one-half inch gong, self-contained hook switch, three-point push-button switch, induction coil, twenty-four-inch cord, one-piece binding-posts, solid double-pole receiver, button type transmitter, with all connections soldered. This folder will be sent upon request.

THE BUFFALO FORGE COMPANY, Buffalo, N. Y., is distributing three attractive booklets descriptive, respectively, of "Volume Blowers and Exhausters," "Mechanical Induced Draught," and "A Compound Engine Test." Each of these booklets describes and illustrates the line of machinery manufactured by this company for the particular work involved. The compound engine test was made at Sibley College, Cornell University, Ithaca, N. Y., and was to determine the water consumption, mechanical efficiency, speed regulation and running qualities of the engine.

THE MILNE BOILER COMPANY, 95-97 Liberty street, New York city, manufacturer of steam boilers and superheaters, will be pleased to send an attractive catalogue descriptive of the Milne high-pressure boiler and superheater. This boiler has four members only—an upper cylinder, a lower cylinder, the steam generating tubes, and the back feed water reheating or economizer tubes, the construction embodying a boiler and economizer combined. The design of the superheater also is simple, having only three members—an upper header, a lower header and the expanded superheating tubes.

THE EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., is mailing a unique and attractive folder, the title of which is "Yoking Our Interests." The company solicits the cooperation of every one who has any need of electrical supplies, and offers prompt deliveries and exceptional quality. The Ewing-Merkle company is now the selling agent for the Jandus Electric Company arc lamps, Bryan-Marsh incandescent lamps, Commercial Electric Company dynamos and motors, Diehl Manufacturing Company direct-current fans, and Sumter Telephone Manufacturing Company telephones and switchboards.

THE LUNKENHEIMER COMPANY, Cincinnati, Ohio, manufacturer of brass and iron steam specialties and engineering appliances, reports that, owing to the unprecedented and growing demand for its products, it has again greatly increased its facilities, and is now in a position to guarantee reasonably prompt shipments. The company also reports that its foreign branches are increasing the export demand for these specialties, and the information is given that the company will shortly place some new specialties upon the market. These specialties will be listed in a complete catalogue, to be issued in the course of a few months.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., held its annual banquet on January 9. At this time a series of papers was read by the salesmen and heads of departments, dealing with origin, care and shipment of an order. The taking and shipping of an order would seem a simple matter. As developed by the papers read, it becomes evident that there is a large amount of care, knowledge and thought necessary to properly handle an order to the satisfaction of an up-to-date supply house and of a wide-awake customer. The Electric Appliance Company has surrounded itself with a splendid organization and a bright set of men, and is rapidly forging ahead in modern business ways.

THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD has, with its customary enterprise, reproduced an illustration from the household number of *Collier's Magazine*, December 26, containing a striking example of the universality of its advertising. This is a picture of Vice-Consul William Magelssen sitting in his office at Beirut, Syria. On the wall just back of him is a proclamation of the World's Fair at St. Louis. Under it is a half-sheet card announcing the placing in service of the Twentieth Century Limited, the twenty-hour train which "saves a day" between New York and Chicago, by the New York Central and Lake Shore railroads. This half sheet is found in the principal transportation offices of every country on the globe.

THE KNOWLES STEAM PUMP WORKS, 114-118 Liberty street, New York city, with works at East Cambridge, Mass., in its new general catalogue for 1904 shows a number of illustrations of different types of direct-acting steam pumps for boiler-feeding, mine drainage, waterworks service, etc. The catalogue, which contains about 150 pages, also lists electric and belt-driven pumps, artesian well pumps, air compressors and ammonia pumps, both flywheel and direct-acting, jet condensers, relief valves, air and circulating pumps, wrecking pumps, vacuum pumps, sugar-house pumping machinery, and, in fact, pumping machinery of every type and for every purpose found in engineering. This catalogue will be supplied free, upon request, to those interested.

THE R. THOMAS & SONS COMPANY, East Liverpool, Ohio, with sales office at 39 Cortlandt street, New York city, in an attractive catalogue describes and illustrates high-grade porcelain insulators for high-voltage power transmission, and electric light, street railway, third-rail, underground trolley and telephone and telegraph lines. These high-tension insulators are made by the "glaze filling" process. The insulators constructed under this process are claimed to be thoroughly vitrified, and as they are made in separate parts of a uniform thickness, each part is thoroughly glazed; and with the extra layers of glaze used in firing them together, a practically non-puncturable insulator is produced. This catalogue will be sent to those interested upon request.

JORDAN BROTHERS, 74 Beekman street, New York city, electricians and machinists, have ready for immediate shipment a large stock of new and second-hand motors, dynamos, fan motors, engines, pumps and exhaust wheels. This company also contract for all branches of electrical work, and make a specialty of marine engineering. The company are the sole agents for the Standard Lamp Company, manufacturer of the "Standard" electric lamp. A device of great utility manufactured by Jordan Brothers is an emery wheel device for turning commutators, without removing the armature from the dynamo or motor. The device is simple and can be applied to any ordinary dynamo or motor for turning the commutator, and saves the expense and delay of removing the armature and placing it in a lathe. Prices and sizes will be furnished by the company upon request.